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EFFECT OF ALUMINA ON TENSILE STRENGTH OF GLASS

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Abstract

The object of this investigation was to determine what effect Al_2O_3 may exert on the tensile strength of a soda-lime-silica glass when substituted for CaO. In order to accomplish this, it was necessary to construct an apparatus for determining the tensile strength of glass fibers. Two series of glasses were used in which Al_2O_3 was substituted for CaO. It was found that Al_2O_3 increased the tensile strength with the first 1 or 2% addition but then steadily decreased it.

I. Introduction

The tensile strength of glass is an extremely important physical property but it is a difficult one to measure accurately. All brittle materials, of which glass is an example, tend to fail in tension regardless of how failure has been achieved. Most tests designed to measure the strength of glass are therefore merely methods of measuring the tensile strength under the particular conditions of the test. Studies have been made on the effects of oxide composition on such properties of glass as density, viscosity, durability and coefficient of expansion, but the influence of these oxides on the strength of glass is not so well known. The effect of alumina on the strength of glass was selected for detailed investigation, and a simple apparatus was constructed to test the tensile strength of glass fibers.

II. Experimental Work

Apparatus and Test Procedure. The apparatus consisted of a lever arm which was counter-balanced to eliminate the weight of the fiber clamp and the lever arm from the calculations. The centimeter scale was shortened by one half the diameter of the moving weight in order that it would read the true distance at the right edge of the weight. The sliding weight of 261.3 grams was mounted on a ball bearing to reduce friction on the lever arm. The clamp on the lever arm was 5.08 cm. (a) from the pivot point, and the upper clamp was adjustable by a chain to allow for variation in the length of the test fibers. The testing apparatus is shown in Fig. 1.

The test fibers were drawn from the rods. Of the 100 fibers drawn, the greater number were between 0.015 and 0.020 cm. in diameter. The fibers used in these experiments ranged between these limits and averaged 21.1 cm. long. About forty fibers were drawn at one time in a Bunsen flame and beads were fused on each end. These fibers were carefully protected from scratching and were tested immediately to avoid surface deterioration brought about by aging.

The fiber was placed in the apparatus and an initial load of 411.5 grams was applied and then increased to the breaking point. With practice, it was possible to move the weight along the lever arm at a fairly constant rate. The average rate of load increase was 85.4 grams per second.

The diameter of the fiber was measured at the point of failure by a micrometer caliper and the measurement was made from five to seven times.

The following equations were used in computing the breaking load and the tensile strength of the fibers:

$$\text{Breaking load} = K \cdot l = 0.0514 \cdot l$$

$$\text{Tensile strength} = \frac{K \cdot l}{\frac{1}{4}\pi d^2} = \frac{0.0514 \cdot l}{\frac{1}{4}\pi d^2}$$

Where

l = distance on lever-arm scale.
d = diameter of fiber at break.

Computation of K is shown in Fig. 2.

Glasses Tested. Two series of glasses of different compositions were used. The compositions of the glasses in

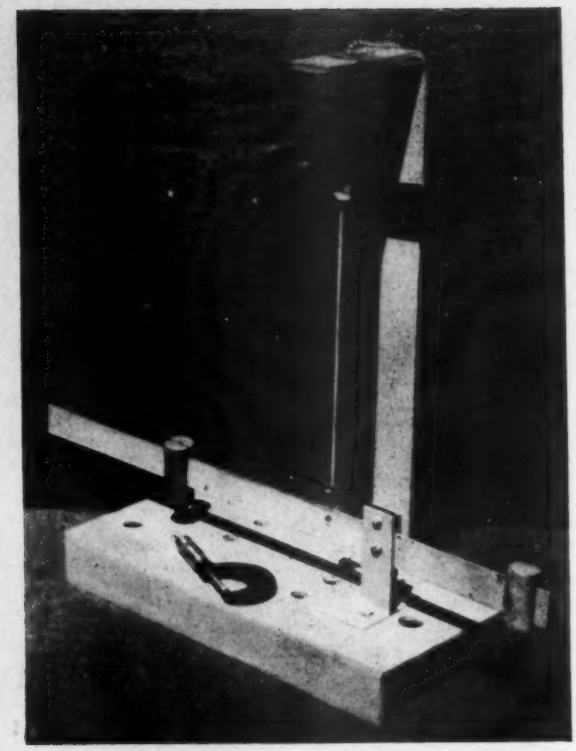


Fig. 1. Apparatus for testing tensile strength of fibers.

Series I are shown in Table I. The base glass contained 75% SiO_2, 18% Na_2O, and 7% CaO.

The compositions of the glasses in Series II are *shown* in Table II. The base glass contained 72% SiO_2, 18% Na_2O, and 10% CaO. In each series, glass I-A and II-A contained no alumina. The alumina was increased by 1% increments as the lime content was reduced; above 7% Al_2O_3, the glasses became too viscous to fine properly.

TABLE I

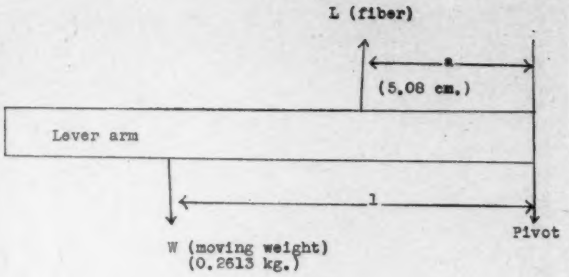
Glass Compositions Series I
(amount %)

Glasses	*I-A*	*I-B*	*I-C*	*I-D*	*I-E*	*I-F*	*I-G*	*I-H*
SiO_2	75	75	75	75	75	75	75	75
Na_2O	18	18	18	18	18	18	18	18
CaO	7	6	5	4	3	2	1	0
Al_2O_3	0	1	2	3	4	5	6	7

TABLE II

Glass Compositions Series II
(amount %)

Glasses	*II-A*	*II-B*	*II-C*	*II-D*	*II-E*	*II-F*	*II-G*	*II-H*
SiO_2	72	72	72	72	72	72	72	72
Na_2O	18	18	18	18	18	18	18	18
CaO	10	9	8	7	6	5	4	3
Al_2O_3	0	1	2	3	4	5	6	7



$$La = Wl$$

$$L = \frac{Wl}{a}$$

$$\frac{W}{a} = K = \frac{0.2613}{5.08} = 0.0514$$

Fig. 2. Lever arm for computing breaking load of fibers.

III. Discussion of Results

The tensile strength of ordinary glass is about 10,000 p.s.i. in rods ½ inch in diameter but has been found to be 3,500,999 p.s.i. in fibers 0.00005 in. in diameter.[1] Anderegg has shown that the strength of glass fibers 0.0060 to 0.0070 in. in diameter is from 40,000 to 45,000 p.s.i., that for silica fibers of the same size the tensile strength is from 50,000 to 60,000 p.s.i. For the most part, the present results agree with these values.

There seems to be considerable variation in the data obtained in each group of determinations. According to Scholes[3], the true tensile strength is not measured but

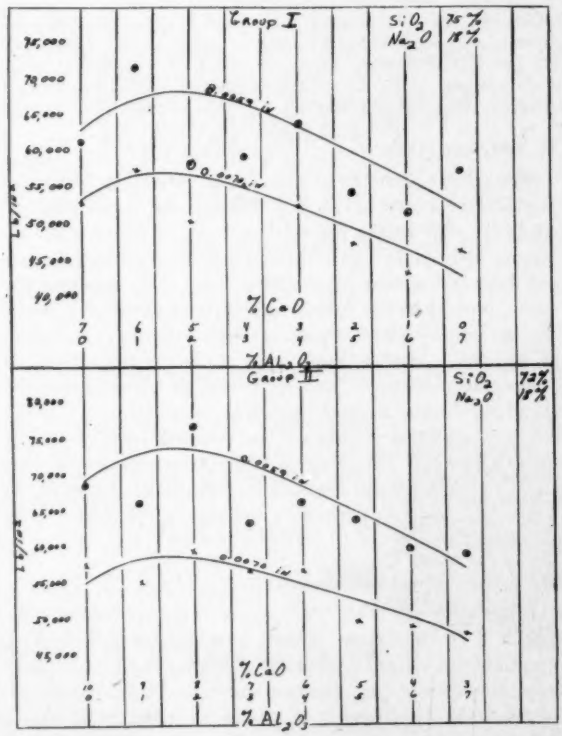


Fig. 3. Variations of tensile strength with glasses, group 1 and group 2, using fibers 0.0059 in. and 0.0070 in. diameter.

only the weakness of the surface. Because of this modification of the surface, variatians of 10% to 20% are possible and even greater ones may be expected.

Some of the average values of the tensile strength may not be accurate because of the relatively few fibers of that diameter obtained. This is especially true of the 0.020-cm. diameter groups.

(*Continued on page* 50)

TABLE III

Summary Tables

Glasses I-A through I-H

Tensile Strength (lb./in.²)

Al_2O_3 (%)

Diameter (In.)	*0%*	*1%*	*2%*	*3%*
0.0059	61,370	71,620	58,200	59,110
0.0062	59,510	66,470	57,260	61,060
0.0066	53,870	57,780	50,520	59,560
0.0070	52,710	57,330	50,550	55,260
0.0074	43,120	54,650	48,130	49,470
0.0078	43,290	49,800	45,690	49,640

Al_2O_3 (%)

	4%	*5%*	*6%*	*7%*
0.0059	63,940	54,390	51,420	57,100
0.0062	64,060	52,060	47,040	53,270
0.0066	58,340	51,480	46,300	47,450
0.0070	52,260	47,210	43,080	46,110
0.0074	48,520	46,800	41,700	42,350
0.0078	45,560	41,360	42,660	38,840

TABLE IV

Summary Tables

Glasses II-A through II-H

Tensile Strength (lb./in.²)

Al_2O_3 (%)

Diameter (In.)	*0%*	*1%*	*2%*	*3%*
0.0059	68,590	66,230	76,690	63,290
0.0062	65,350	61,330	74,160	69,340
0.0066	60,430	59,490	68,280	63,430
0.0070	57,660	55,180	59,580	56,850
0.0074	52,630	50,750	53,010	53,140
0.0078	48,970	53,660	53,760	53,180

Al_2O_3 (%)

	4%	*5%*	*6%*	*7%*
0.0059	66,180	63,810	59,610	58,640
0.0062	63,120	60,220	57,180	54,290
0.0066	58,650	57,100	49,400	52,890
0.0070	56,810	49,600	48,990	47,760
0.0074	49,300	50,260	45,180	42,500
0.0078	46,230	50,420	41,340	37,890

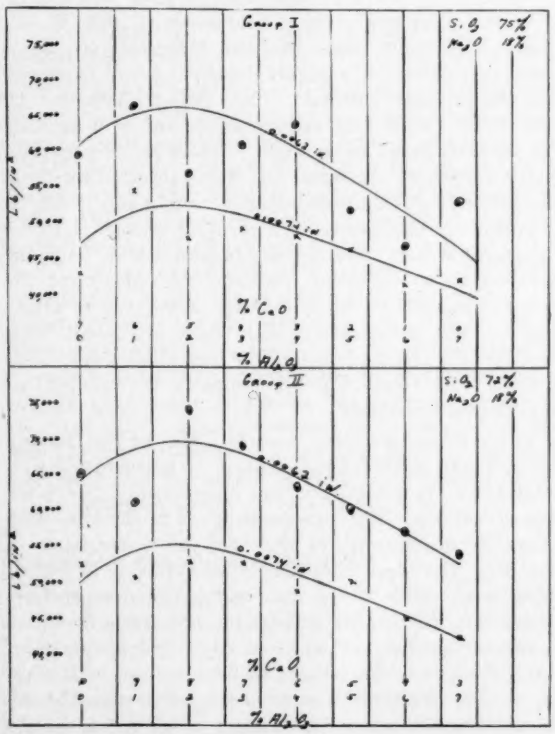


Fig. 4. Variations of tensile strength with glasses, group 1 and group 2, using fibers 0.0062 in. and 0.0074 in. diameter.

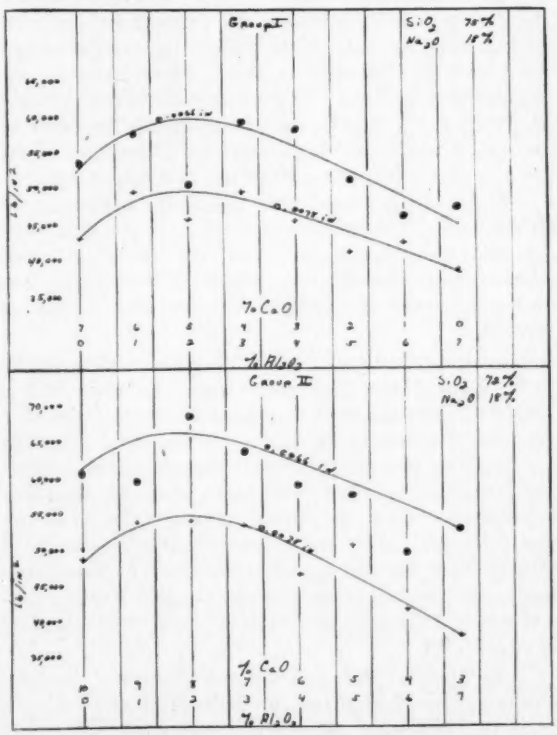


Fig. 5. Variations of tensile strength with glasses, group 1 and group 2, using fibers 0.0066 in. and 0.0078 in. diameter.

ELEVENTH GLASS CONFERENCE AT URBANA

The Eleventh annual conference on Glass Problems, under the combined sponsorship of the University of Illinois and the Ohio State University, was held December 8 and 9, 1949 on the University of Illinois Campus, Urbana, Illinois. The conference sessions, which were attended by a record 171 participants, were held in the University Mathematics Building, and the very comfortable hotel facilities of Champaign-Urbana were utilized for lodging and post-session "glass making".

The program was concerned with three major discussions. First mold and metal problems, at which F. O. Pasotti, Ball Brothers Company, was Chairman. Next, theory and practice in annealing and tempering, with F. G. Schwalbe, Toledo Engineering Company, presiding, and finally a discussion and open forum on quality control in glass manufacture, with A. C. Siefert, Owens-Corning Fiberglas Corporation, Chairman. Dr. H. H. Blau was toastmaster at the special conference dinner on Thursday evening.

The purpose of the conference in furnishing a clearing-house for exchange of ideas, and recently-developed information of a practical nature, was realized by the many questions and expression of opinions from the floor.

Opening the Thursday meeting, Neil Waterbury, Owens-Illinois Glass Company, cited metal problems encountered in orifice rings, gob shears, molds and machine fittings, and gave his opinion as to which metal might give best service in each case. He expressed the general need of the glass industry as being a lightweight, strong metal with a high melting point. He referred to the papers by J. S. Vanick (THE GLASS INDUSTRY, Volume 19, 1938) as the best information presently available on glass mold cast irons. Mr. Waterbury's suggestion of the use of platinum for the orifice ring in a feeder was augmented by suggestions from the floor recommending Driver-Harris #55 stainless steel, and Cooper #22 alloy for the same application. Also, the use of activated alumina was suggested as a means of drying air, thus preventing water-corrosion of high pressure tubing on machines.

After a practical discussion of glasshouse irons by F. W. Dixon, Haven Malleable Castings Company, it was suggested from the floor that hand-shops were probably the most satisfactory trial grounds for mold materials and methods because it is more economical to conduct mold research projects there rather than on automatic machine operations. Mr. Dixon contended that no saving would be realized by chromium-plating expensive mold metals. This was not agreed to by several present who had had experience in using chromium-plated mold parts, and they did not believe plating of cheap mold metals to be worthwhile.

J. R. Murphy, Acheson Colloids Company, contributed an interesting picture of the role of graphite colloids in lubricating glass-molds, and pointed out that oils used for mold-lubrication contain 0.05 to 0.20% colloidal graphite, which acts as it does due to the inability of the hot glass surface to wet the graphite. Mr. Murphy gave a concise history of the development of graphite colloids, explained the theory of the lubricating properties of graphite, and pointed to unsolved problems in developing better lubricants.

Professor H. L. Walker, of the University of Illinois Department of Mining and Metallurgical Engineering, gave a vigorous dissertation on high-temperature, or super, alloys. He showed how thermal resistance and mechanical strength have been improved by the addition of small amounts of aluminum, columbium, titanium and molybdenum to stainless steels. These crystallize as small nuclei between slip-planes and prevent creep. Consequently, points of failure have moved to the grain-boundaries and, hence, current research is directed toward strengthening these by creating higher-temperature eutectic mixtures by eliminating impurities in the raw materials. Professor Walker pointed to the weaknesses of the present high-nickel stainless steels which are embrittled by sulfur, produce seeds in glass due to dissolved hydrogen, and necessitate slower press operation due to low thermal conductivity. After listing the best-known alloys for metal requirements in ten major glassmaking operations, he tabulated alloy compositions with corresponding strengths at temperatures of usage. Best listed had a 100 hour stress-to-rupture of 23,000 psi at 1500°F. It was emphasized that higher cost is a requisite of higher heat resistance in currently available alloys.

At the Thursday evening conference dinner, W. W. Wood, of Kimble Glass Division, Owens-Illinois Glass Company, delivered a highly interesting and entertaining dissertation entitled, "Can Safety Attitudes be Changed?" Clothing his remarks in an outline of methods for securing better cooperation in plant safety programs and reduction of accidents, Mr. Wood revealed the basic requirements of successful human relationships. He illustrated the importance of a pleasant attitude, and the "warm approach" between department heads, and also between them and their workers. He illustrated his points remarkably well by relating experiences of safety men in their relationships with plant personnel. Incidentally, his talk is presented in part in the May, 1949 issue of THE GLASS INDUSTRY, making it available for any desired reference.

At the Friday meeting, Howard Lillie, of the Corning Glass Works, opened the discussion of heat-treating with remarks on the basic principles of annealing. Since the rate of adjustment of stresses in glass in the annealing range is proportional to the level of temperature in that zone, the ideal condition in annealing is to get all parts of any piece of the ware to the same temperature. In practice, this is made difficult by thickness differences, gradients existing in glass from any forming operation, and difficulty in controlling like temperatures with varying loads. Hence, it is necessary to determine the acceptable amount of residual stress for any item by experiment. Mr. Lillie pointed out that the previously observed theory that "remaining stress is equal to and

(*Continued on page* 48)

BASIC PRINCIPLES OF GLASS TEMPERING

By RALPH K. DAY

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Introduction

A discussion on glass when the subject includes the words "basic principles", should start with the most interesting question of all; namely, "What is glass? Is it a liquid or a solid?" That question is still unanswered. The entire technology of glass is particularly interesting because so many simple questions which are reasonably answered for other materials remain as question marks for glass. Professor Smekal from Germany who visited in the United States this year did mention a good reason why it is so difficult to correlate the results of rod-breaking experiments used to study the strength of glass. Professor Smekal asked, "Did you ever notice that even though we calculate the maximum tension to be under the central knife edge, the rod actually never breaks at this point?"

Glass is a very strong material; stronger than steel. Its practical strength is limited, however, by the variable weakness of its surfaces due to incipient fissures. It is to strengthen the surface and prevent these incipient fissures from becoming cracks that we temper glass. The compression on any particular surface of a piece of tempered glass must first be overcome by mechanically or thermally induced tension forces before the incipient fissures in the glass surface can begin to enlarge to form cracks with resultant breakage.

Definition

What is tempered glass? It is probably not like tempered steel though the process is similar to the process of heating and quenching steel to achieve a temper. The word "probably" is introduced into this statement because we are today beginning to recognize differences between the fundamental nature of quenched glass and annealed glass. We know that the density and other physical properties are different. The surface layers of tempered glass which are cooled faster may therefore be expected to be slightly different in physical properties than the interior glass layers of an annealed glass, but these differences are small for most glasses compared to the physical strains which are introduced by tempering. We had better, therefore, leave this question along with the question, "Is glass a liquid or a solid?" and go ahead assuming that the nature of glass is unchanged from a practical standpoint by the tempering process.

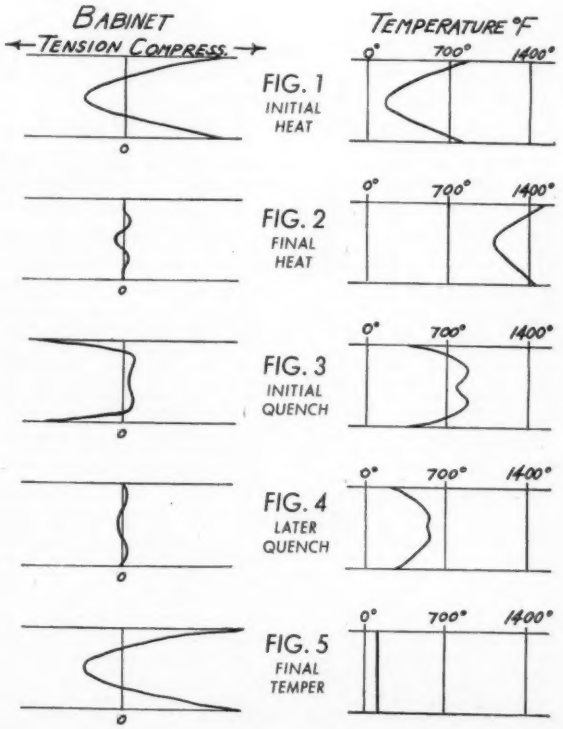
Example: Unannealed Bottle

Tempered glass may be described as intelligently strained glass. Many people have seen the popular lecture experiment with the bottle which is taken directly from the machine and set out to cool without annealing. This bottle is tempered. It can be used to drive a nail into a board. The outside surfaces are in compression and the inside glass is under tension, but in this case the inside tension is at the interior virgin surfaces of the bottle which have not been touched and which are free of those incipient fissures which easily develop into cracks. A small chip of glass dropped into the interior of this bottle will cause the entire bottle to explode.

To intelligently temper glass, all glass surfaces must be cooled so that they end up in compression balancing the tension forces which must be completely buried under the surface. If the inside of the bottle is not to be filled with a sharp cornered material, it is sometimes a good thing to incompletely anneal a freshly made bottle for added strength on the outside where the abuse occurs. It should be repeated, however, that true temper in glass requires that all surface glass be under compression.

Example: Plate Glass

To illustrate the tempering process itself, let us assume that we have a piece of plate glass infinite in area and let us watch a cross-section, seen in a Babinet Compensator, as the glass is uniformly heated and then its surfaces are rapidly and uniformly cooled to temper. The Babinet Compensator is an optical system in which annealed glass shows a vertical neutral line. When strain is present in the glass, the line goes to the right for compression and to the left for tension. Schematic approxi-



Presented before the Eleventh Conference on Glass Problems, University of Illinois, Urbana, Illinois.

mate sketches, Figs. 1 to 5, illustrate the temperature gradients and stresses present in the various stages of tempering glass.

As the glass is heated, the surface of the glass expands and goes into temporary compression as illustrated in Figure 1. As the heating is continued and the surface temperatures exceed the softening temperature, the compressive stress is relieved by flow contraction, and the strain line on the Babinet Compensator assumes its neutral position at the surface of the glass as shown in Figure 2[a]. Up to this point, you will notice that the glass surfaces are always either under compression or in a fluid state so that there is little danger of breakage from abusive handling.

The glass is now rapidly and uniformly quenched. In this operation, all of the softened glass surfaces must stretch until the temperature becomes low enough so that further contraction due to thermal shrinkage changes from actual stretch into attempted stretch which is tension. The undersurface glass must, of course, have reached a softened temperature where flow is possible because the surface glass must continue to stretch as it is quenched to a temperature below the temperature of the interior glass in order for the final differential shrinkage to leave the surface layers "longer" (final room temperature compression) and the interior layers "shorter" (final room temperature tension).[a]

If all of the glass surfaces are not hot enough so that they can stretch in this quenching operation, the surface is broken into what are commonly called "chill checks". If all surfaces are hot enough, they will stretch, and as they further cool and set up, all surfaces will be in temporary tension as shown in Figure 3. At this stage of the tempering operation, any abuse of the surface will cause breakage. Great care must therefore be taken in supporting the article during the quenching operation.

Figure 4 shows a later stage of cooling in the quenching medium. The interior of the glass has cooled down and is approaching the temperature of the surfaces. The temporary tension is shown at about the neutral point on its way to changing into compression.

Figure 5 shows the temporary pattern of Figure 3 entirely reversed and we have the final condition of compression on the surfaces balanced by tension in the middle of the glass. You will notice that the strain pattern of the glass, which is now again entirely at room temperature, is the same shape as the temporary pattern in the glass during the heating cycle. (Figure 1.)

The process of tempering an infinite piece of plate glass has been used to illustrate tempering from an idealistic point of view. The heating method has been assumed to be uniform and the chilling fluid, whether it is a liquid or a gas, has been assumed to be applied uniformly.

Example: Special Shape

Commercial glass products which are being tempered are usually not as simple as a piece of plate glass and even commercial plate glass must have edges and be finite in size. To illustrate tempering problems on special shapes, a new product which we will call a Whatzit has been designed. This particular article whose cross-section is shown in Figure 6 may have some usefulness somewhere but it is designed primarily to be particularly difficult to temper.

In the plate glass tempering operation just discussed, it was mentioned that the surface of the glass should be uniformly heated and then rapidly and uniformly cooled. Cooling must be by a tempering medium which may be oil, molten salt, air, or any other medium, but, in any event, the cooling is all conduction and is brought about by natural convection or by forced motion of the cooling medium.[b] Some time ago, Dr. J. T. Littleton pointed out to me the experiment in which you heat a wire to dull redness by passage of an electric current and then blow it out. If you haven't tried this experiment, you should do so because it will convince you how effective slight motion of the cooling medium, your breath in this case, is. Remember this principle in your tempering operations.

If the Whatzit is chilled in an upside down position or partially so, the cooling medium must be forced into motion in the pockets which face downward. Otherwise, these downward facing surfaces will end up as points of weakness due to the impossibility of natural convection. Convection currents result from the tendency of a hot gas or liquid to rise because of its lower density. The quenching medium, which is in contact with a downward facing pocket, gets heated from its contact with the hot glass but then it cannot go anywhere. It wants to rise and cannot, so it stays put and continues to get hotter and hotter. It is painful experience, not just theory, which says that insufficient temper results in that area. Please notice that the Whatzit should also not be quenched in an exactly upright position because in that position natural convection will not be able to adequately cool the cupped bottom.

In the design of the Whatzit you will recognize the exaggerated bottom contours of a bottle with a thin lip added. It was stated before that this shape was designed to be difficult to temper and what we want to consider now are the structural stresses which will be superimposed on the cross-sectional strain pattern due to the shape of this article. Let us heat the article uniformly and temper it in a nearly right side up position so that no pockets will prevent the normal convection cooling cur-

(a) Actual measurements of the dimensional changes occurring in glass as it is changed from its original annealed condition without internal stresses to its final tempered condition with compression on the surface and tension on the interior are not known to the author. However, if we were to (or could) slice the uniformly tempered piece of plate glass into very thin sections parallel to the surfaces, we would certainly expect the outside thin sections to be larger in area than the central thin sections due to relief of compression and tension stresses respectively. These outside thin sections must therefore have stretched at some stage of the tempering operation and this phenomenon must take place during the quench. Shrinkage of the surface was mentioned as occurring when the glass surfaces which are under temporary compression due to rapid heating reach a temperature of stress release. This temporary shrinkage of the surface due to rapid heating must also finally be overcome by stretching during the quench because the final stresses in the glass (maximum compression plus maximum tension) must be proportional to the difference in the linear dimension of the very thin section at the compression surface and the very thin section at the central section of maximum tension by Young's Modulus. It is a known fact that rapid heating of a glass surface, followed by natural cooling (not a quench and therefore a shrinkage but not a stretch) leaves the glass after it is again at room temperature with permanent tension on the surface balanced by interior compression. This phenomenon has been observed after rapidly polishing the surface of a previously well-annealed piece of glass.

(b) In most industrial operations, the specific heat of the quenching medium is the method of removing the heat from the glass surface. The latent heat of evaporation (generally of water) and the heat of decomposition (as in oil quenching) is generally larger than the specific heat alone and must be taken into account when present. Examples of this are the persistent presence of water in a freshly prepared molten salt bath (R. K. Day patent #2,263,489), the presence of actual water (not water vapor) in the air used for tempering, and the volatile components present in a "new" oil quench bath. The best practical cure for trouble from these causes is to test the tempered glass article from a "new bath" compared to that from an old bath and "cooking" the new bath until a constantly tempered product results. In the case of air tempering, water in the air should be removed. Deliberate introduction of water spray into air tempering has generally been found to affect the temper so violently as to make the process difficult to control.

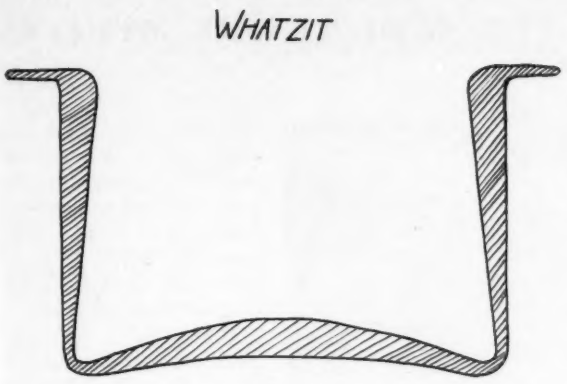


FIG. 6

rents mentioned before. If all surfaces are chilled simultaneously and uniformly, it is obvious that the inside corner of the bottom as well as the edges of the rim will be set up before the center of the bottom or sidewall sections have time to cool and set up. The edges of the rim will set up first and act as a very strong circular bridge structure from which the entire Whatzit still has to shrink away as it cools. The edge of the rim which will end up in strong circumferential compression will not be a vulnerable spot but what effect will this ring have on the rest of the Whatzit? The thin sections at the edge of the bottom will also set up before the heavy central section of the bottom sets up so the circular section comprising the circumference of the bottom will again be a ring structure in circumferential compression. If you can visualize the structural effects of setting up the edge of the rim as well as the thin sections at the circumference of the bottom ahead of the rest of the glass, you will come to the theoretical conclusion that tension will be the final condition of the surface glass at the inside corners of the bottom and under the rim. It works out just that way in practice. The design of a glass article must take these principles into account. Thick sections will cool slower than thin sections and structural strains will thus be introduced which are superimposed and frequently neutralize the cross-sectional compression and tension strains which we are deliberately introducing to temper and strengthen the article.

Degree of Temper and Its Control

What about the degree of temper, its control and measurement? The most important statement to make on this subject is that uniformity of temper is more important than degree. If an Achilles' heel of weakness remains at any spot in the article, high temper in the remaining portion only accentuates the explosiveness of the break when it occurs. The ultimate resistance of the glass article to mechanical or thermal breakage is determined by the weakest link as usual. That is the reason for the previous emphasis on design of the article and its handling during tempering.

The degree of temper can be set at most any level desired from a very light temper which adds a slight degree of strength, to a heavy temper which adds greater strength, by suitable choice of quenching intensity and method. The degree of temper is directly proportional to the final amount of surface stretch when the glass is quenched. The temperature of the glass surface at the time of quench will determine its resistance to stretch and in air tempering, if the air blast is mild enough not to cause chill checks, less heating causes less final temper. In general, however, the glass surfaces must be heated hot enough so they can stretch and the cooling rate determines the total stretch or degree of temper. In liquid tempering, the nature of the cooling liquid and its temperature directly determine the degree of final temper in practice.

Tests for Degree of Temper

The Babinet Compensator or its slightly simpler blood brother, the quartz wedge, can be used to examine a cross-section cut from the article and obtain a direct measure of its degree of temper. These instruments can be calibrated to read absolute compression or tension in lbs./sq. in. A ¼-inch wide section at least one inch long sawed out of the glass article provides a suitable sample for Babinet or quartz wedge examination if the temper is low enough so that you can saw out such a section. Remember, however, that structural strains are removed by sawing out a section. If you saw out a cross-section of the normally tempered Whatzit, the inside corner of the bottom and outside surface under the rim will show compression restored to these surfaces.

Polariscope examination with the light path normal to the surfaces of our infinitely large piece of plate glass, which has been ideally and uniformly tempered, will show absolutely no change of color, regardless of the degree of temper. All color developed in the polariscope in this test is caused by either non-uniformity of temper or edge effect (shape factor). If two pieces of glass of a given shape are tempered by exactly the same method with the only difference being the degree of temper, the polariscope pattern will be closely the same. It is true that the colors actually seen which are the result of shape and uniformity of the tempering as noted above, would be augmented by a higher degree of temper but the important practical interpretation of the polariscope pattern of the piece of glass is distribution of temper and effect of the shape of the article. The polariscope is a satisfactory control instrument for determining uniformity of temper but it is of little use to determine the degree.

Glass can be tempered to a limited degree without materially affecting the number and shape of pieces when breakage occurs. Higher degrees of temper cause glass to "dice" when it is broken. Here is a good practical test for degree of temper. Drill a hole into the glass or otherwise break it without addition of excessive energy. The resulting fracture will release the strain energy tied up in the glass due to tempering and the amount of energy, which is proportional to the degree of temper, will reveal itself by the size of the pieces. The higher the temper, the smaller the pieces. Variable temper, either accidental or deliberate, can be studied by examining the size distribution of the pieces in cases where glass had been tempered to a "dicing" degree.

Strength of Article Tests

How should we test our tempered glass product? It was mentioned earlier that mechanical breaking tests are difficult because of the variable incipient cracks on all

(*Continued on page* 50)

G.C.M.I. RETURNS TO MIAMI FOR SEMI-ANNUAL MEETING

Getting off with a flying start, the semi-annual meeting of the Glass Container Manufacturers Institute was held under the auspices of the Board of Trustees December 12, 13 and 14 in the Kenilworth Hotel, Miami Beach. Lewis F. Gayner, Chairman of the Board of Trustees, opened the meeting with an address keynoting the agenda of reports and discussions which immediately followed, and which began with remarks by Ben Wood, Director of Marketing for the group, and by members of the Committee on Market Research and Promotion and the Institute's advertising agency, Foote, Cone & Belding.

Left to right: Benjamin Wood, Victor L. Hall, Dr. Edwin G. Nourse and Lewis F. Gayner.

The Committee's report, submitted by its Chairman, I. J. Collins, Chairman of the Board of the Anchor Hocking Glass Corporation, reviewed the Institute's advertising and merchandising campaign in support of the One-Way beer bottle, and also covered the public relations program during the past six months. The use of newspaper advertising in regional promotions was reported in detail, and Mr. Collins told how the first campaign to embrace "catch all" areas covered 45 cities in the states of Texas, Oklahoma, Mississippi, Missouri, Indiana, Iowa, Tennessee, Georgia, Louisiana, West Virginia plus Cincinnati.

Cartoon ads, the report revealed, are now appearing in the five Baltimore-Washington newspapers and in nine newspapers in the northern New Jersey area. In June campaigns were started in nine Michigan cities and Toledo, six more being added in July. June also witnessed the opening of another campaign in Maine, Vermont and upstate New York, while a still more intensive drive, combining newspapers and 100 billboards, was undertaken in New York City from August 25 to November 10. All campaigns, the report pointed out, received brewer and retailer support via newspaper space, billboards, radio, television and merchandising aid.

Other portions of the report dealt with point-of-sale and merchandising material, as well as helpful surveys, contributed by Foote, Cone & Belding. Mention was made of the effective display program conducted by the West Coast Marketing Director, William Cooke, which resulted in thousands of One-Way bottle displays in that region of the country.

On the public relations side, the report continued, Theodor Swanson & Company, public relations counsel to GCMI, has increased the circulation of "Glass Container News" from its original figure of 20,000 to 29,000, almost entirely by request. Stressing the high "box score" of releases accepted by general publications and trade magazines, the Committee recounted the firm's continuing success in building up an information library for the industry and in distributing copies of the addresses made by Mr. Wood before important trade groups.

The report of the Traffic Committee, presented by B. H. Taylor, Traffic Director of the Institute, reviewed the rail freight increases which became effective September 1, and told how the Interstate Commerce Commission in its decision commented on the need for restoring former rate relationships as completely and as quickly as possible. In the opinion of the Committee, the report disclosed, the Commission's specific mention of the changed relationship, for example, between the cost of conveying

(*Continued on page* 57)

Mrs. Warren receives a silver service presented in recognition of past President Robert L. Warren's services to the industry. Toastmaster Royden A. Blunt is assisted by George F. Lang and Charles D. Rau as Mrs. Lewis F. Gayner looks on.

THAT CURIOUS WORD "LEHR"

BY PROFESSOR W. E. S. TURNER
Sheffield, England

Editor
The Glass Industry
New York 18, N. Y.

At a meeting of the Society of Glass Technology in Edinburgh, I gave a talk on the word "lehr". I had been interested in the origin of the spelling of this word and have been delving into the subject for nine or ten months. Recently I wrote up the talk, after still further investigations, in the form of a paper.

The subject is one of much interest to American, as to English, readers. Indeed, after my Edinburgh talk, it was suggested to me that I might consider simultaneous publication in America and in England, especially as I am advocating the return to the old and correct spelling, "leer".

I am enclosing a slip proof copy should you care to publish it in an early number of The Glass Industry.

Yours sincerely,
W. E. S. Turner

Introduction

In July 1928 I received from Mr. George Dowse of the British Patent Office a letter with which he enclosed some notes on an investigation he had been making into the correctness of the prevailing spelling of the word "lehr". Mr. Dowse had come to the conclusion that the original spelling was "leer" and that the word was first used in England.

I was quite aware of the spelling "leer", as, for example, in H. J. Powell's authoritative *Glassmaking in England* published in 1923; but I also knew of other variants in historical records. It was my intention to enquire further into the history of the word and of the modern term "lehr"; but a multitude of other claims constantly pressed on me. Moreover, it seemed to me that the form of the word "lehr" was so well established and in such widespread use, that the subject was one perhaps more of academic than practical interest. Thus my good intention was first diverted and then forgotten for twenty years; the whereabouts of Mr. Dowse's letter and notes were forgotten, and I had come to the end of my recent much more extensive research before the letter was recovered from my old files. Nevertheless, I gladly make acknowledgment here of Mr. Dowse's letter and notes which, so far as I know, first raised the question to which this article is devoted.

My interest in the subject was reawakened by receipt of a letter dated August 25th, 1948 from Mr. W. N. Wheat of Chance Brothers Limited, who wrote asking for the true meaning of the word "lehr" and for references to authoritative publications in which the word was used in connection with annealing kilns or furnaces. The matter became once more alive for me. It was quite easy to prove that the word "lehr", or its older form "leer", connoted a tunnel kiln, one end of which was hot and the other cool, as used for the annealing of glass. That meaning, as I shall show, goes back to the seventeenth century. The correct form of spelling, however, was another and more interesting phase of the subject. What follows below sets out the course and the final conclusion of the enquiry.

The Word "Lehr"

Although my enquiry into the origin of this word had been very long postponed, its curious spelling had not unnaturally raised in my mind and, as I found by conversation in the minds of others, what it signified and how it originated. The two and only suggestions made to me of its origin were associated with Germany, one being that it was so called after a man's name, the other that it might be some corruption of the German word "leer", meaning empty. These suggestions directed my first systematic searches to the German literature of the nineteenth and twentieth centuries. I was surprised to find no trace either of the word "lehr" or indeed of any equivalent word. Thus, there is no mention of such a word in H. Leng's systematic *Handbuch der Glasfabrikation* of 1835, nor in those of N. Graeger in 1868, or E. Tscheuschner of 1885. H. C. Benrath, the most scholarly of the German textbook writers of the nineteenth century, used (1875), like earlier and later German writers the word "kühlofen". In the heading to the section entitled "Kühlöfen" he quoted in parenthesis the French and English equivalents as "four à recuire, leer, cooling furnace". Of the later German writers, R. Dralle, both in the first edition of 1886 and that of 1911, employed only the term "kühlofen". That is the only term still employed in *Dralle-Keppeler*, Volume I, 1925, although two types are distinguished, namely, "kühlöfen" and "kanalkühlöfen". In Volume II, 1931, of *Dralle-Keppeler*, which is devoted to the special technical processes in each of the major branches of the industry, there are several references in the section on glass-bottle manufacture (see pp. 1060—1073) to the word "lehr", but only in quoting modern English and American literature or in describing industrial plants of American design. F. Späte in his *Weiss-Hohl- und Geräteglas*, published in 1931, uses the term "kühlöfen" throughout in the text, but there is a footnote on page 69, referring to an article in the American *The Glass Industry* in 1923 on "Initial Heat Lehrs". Finally, as late as 1940, in a comprehensive compendium published at Frankfurt under the editorship of Dr. Ing. H. Maurach, there is no use or even reference to the term "lehr" when discussing the various types of modern annealing furnaces.

So much for the suggestion that the word "lehr" is of German origin. If it had been, it is most certain that the German literature would have employed it.

If the word "lehr" is of foreign origin one would expect that it had come into use in England through the immigrant glass-makers who came to the country between the twelfth and the seventeenth centuries. German workmen were not amongst those who influenced or stimulated British glass-making. But both Italian and French workmen did exercise a powerful influence on the development of the industry. It can be said, however, that neither the word "lehr" nor any of the earlier forms "leer" or "lear" seems to owe its origin to Venetian or other Italian words. There are three texts which bear on

this point, two by Italian writers, one by a German writing in Latin. The first is that of *De la Pirotechnia*, by Vannorcio Biringuccio. The first edition of this writer's book, printed in Venice, was published in 1540. It was written in Italian, and an English translation was made by C. Stanley Smith and Martha Teach Gnudi for the American Institute of Mining and Metallurgical Engineers, New York, which published the translation in 1943. Chapter 14 of Book II of this work deals with glass and semi-minerals. There is no special term used by which the cooling of the glass is described, nor is the part of the furnace where the cooling occurs given any special name. The translators, in a footnote on page 128, state that "as on other subjects, Agricola (*De re metallica*, Book XII, pp. 472—5) copies Biringuccio's description of glass-making but adds important variants on the practice, including the use of a separate annealing lehr". It must be clearly understood that the use of the word "lehr" in this connection is by the translators only, and they would, in my view, have maintained the historical context better by using the term "furnace" instead of "annealing lehr".

The second text is that of the author just referred to, Georgius Agricola, namely, *De re metallica*, published in Basel in 1556. Agricola, whose classical work in Latin, covers the field of mining and metallurgy, included a section on glass-making, knowledge of which he claims to have obtained from his observations in Venice. His illustrations by woodcuts of the types of glass furnaces in use have been copied frequently by later writers. In his description of these furnaces, and in particular of that part of the furnace where the glass is placed in order that it may cool slowly, no special term equivalent to "leer" is employed.

The third text is that of Antonio Neri, entitled *L'Arte Vetraria*, written in Italian at Florence in 1611. Whereas in the works of Biringuccio and Agricola, glass-making is only one of many processes described, that of Neri is entirely devoted to the subject. In it he sets out what he has learned of the glass-making recipes and methods at Venice and in the Netherlands. The book, however, contains no description of the furnaces employed or of the processes of cooling the glass.

To sum up, it appears that neither the word "lehr" nor its forerunner "leer" originated through Italian terminology of glass-making methods.

As to the source of the word being possibly French, my search of the literature brought results closely similar to those arising from the perusal of German literature. From the time of G. Bontemps and his book *Guide du Verrier* published in 1868, and the books of Jules Henriveaux *Le Verre et le Crystal*, published in 1883, and of *Verre et Verrerie*, by L. Appert and J. Henriveaux, published in 1894, down to the present day, the name of the piece of equipment by which glass is annealed is simply an annealing furnace. No single word corresponding to "lehr" exists. One hundred and fifty years earlier, M. Haudicques de Blancourt published his book *De L'Art de la Verrerie* in Paris in 1697. The book was clearly based on that of Neri, but he does refer to furnaces employed in glass-making and states that the upper part of the furnace is used for annealing the ware. There is no mention, however, of any specific term for this part of the furnace, nor is there any such term in the English translation of the book: *The Art of Glass*, published in London in 1699.

Is the Word "Lehr" of English or American Origin?

My first close contact with the glass industry began towards the end of 1914, when I learned that the particular type of furnace used for the continuous annealing of bottles was known as a "lehr". This word was definitely used by all those who took part in a discussion at the February, 1917 meeting of the Society of Glass Technology when Mr. F. Twyman read his paper on "The Annealing of Glass". Mr. G. E. Alexander, in a paper to the Society on April 18th, 1917 described devices used in America in conjunction with the Owens machine "by which the bottles are conveyed to the annealing lehr". The introduction of the word into technological usage in the glass industry in England, although evidently fairly well established by 1915, does not seem to have been brought in at the time when the first Owens machine was erected in England at Trafford Park. The *Quarterly Reports of the Glass Bottle Makers of Yorkshire United Trade Protection Society* for 1907—9 contains a description of the operation of a newly erected Owens machine at Belfast, together with the latest mechanical devices. The bottles were then described as passing direct into "annealing pans" and thence into the "annealing chamber".

In printed literature in England the term "lehr" does not appear earlier than 1910. Throughout the eighteenth and nineteenth centuries, one of the terms "leer", "lier" or "lear" was employed in England.* The form "lear" appears in the Excise Regulations relating to glass-making early in the nineteenth century.** This same form of the word is used in the *History of Chance Brothers and Company*, by J. F. Chance, published for private circulation in 1919 in connection with the centenary celebration of the firm's establishment. Whenever in that *History* a continuous annealing furnace is described by a single specific word it appears as the form "lear". The same spelling was adopted by W. Rosenhain in his *Glass Manufacture* published in 1915, but as Dr. Rosenhain had been associated with Chance Brothers as research chief, his use of "lear" was natural. The first official cognisance† of the spelling "lehr" appears in the English Patent Specifications in 1919 in connection with the English Patent

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*For example: 1727—51, *Chambers Cyclopaedia*, s.v. FURNACE, "the leer is an avenue four or five yards long, continued to the tower."

1797. *Encyclopaedia Britannica* (Third Edn.) VII, p. 768, "the third oven or leer."

1801. P. Wakefield in *Mental Improvements*, Vol. I (1801), p. 143: "the lear or third furnace."

1832. G. R. Porter in *Porcelain and Glass*, p. 158: "The annealing oven or lier is a long rectangular chamber . . . furnished with . . . iron trays. These trays are called leer pans or fraiches."

1839. A. Ure, in *Dictionary of the Arts, Manufacturers and Mines*, p. 579: "The cooling or annealing arch, or leer, . . . The Leer pans . . ."

p. 584. "The flint glass lear . . . is an arched gallery or large flue, about 36 feet long, 3 feet high, 4 wide . . .

1890. Gordon, in the *Foundry*, p. 140: "The tunnel is the 'lear' and the process is known as 'lear-annealing.' "

**See quotations in W. E. S. Turner's "The British Glass Industry: its Development and Outlook," this J., TRANS., 1922, 6, 108—146.

†In the three volumes of Abridgements of Specifications, Class 56, "Glass," issued in 1910, 1920 and 1924, respectively, by H. M. Stationery Office, London, and dealing with the periods 1905—08, 1909—15 and 1916—20, the general heading under which annealing devices are listed was "Annealing, Tempering and Toughening." In the period 1916-20, a sub-heading was added, namely, "Lehrs and Kilns for." In the 1905—08 period, no specification contained the word "lehr" or "leer"; in the 1909—15 period, two specifications were for "leers" and none for "lehrs"; whilst, in 1916—20, despite the new sub-heading, one specification (No. 113,974 of 1916) referred to a "leer."

123,254 of June 13th, 1918, J. and G. Keith, London, granted in connection with glass annealing "lehrs". Two years earlier, in the *Journal of the Society of Chemical Industry* for 1917, Abstracts, p. 1274, there appeared an abstract of U. S. Patent No. 1,243,777 of October 23rd, 1917, taken out by H. I. F. Strandh, of Sweden, for a channel oven, drying oven, or the like and the general description of the class of device was: (Glass Lehr). It does not appear, however, that the inventor himself referred to his device as a lehr.* Certainly in Sweden the term does not seem to have been in use at the time. In the book by C. Kaiyser and S. Fogelberg, entitled *Sveriges Smu glasindustri* published at Stockholm in 1922, annealing is described as a process of cooling and no special term is given to the furnace by which the process is carried out.

All the evidence pointed to the probability that the form "lehr" had come into the English language by way of the U.S.A. I found my first reference to it in an address by Mr. T. W. Rowe entitled "Mechanical Progress and the Owens Machine" printed on pp. 1—6 of the *Official Magazine of the American Flint Glass Workers' Union of North America,* for April, 1910. Mr. Rowe, then President of the American Flint Glass Workers' Union, described the new plant in the course of erection at Fairmont, W. Va., by which all the processes of bottle-making (using the Owens machine as basis) were mechanized. He referred to the older method by which bottles were "carried by boys into the annealing lehr". Under the new system he said, "the lehr, being part of the machine, anneals the bottle and dumps it at the exit end of the annealing lehr". Clearly by 1910 the form of the word "lehr" was known in the American glass-bottle trade. The H. L. Dixon Company's catalogue, *Everything for the Glasshouse,* well known in its day and first copyrighted in 1908, contains in the introduction a paragraph which commences, "The introduction and perfection of the continuous lehr for annealing plate glass etc". However, the same company, as well as other engineering firms, were, in 1895,** using the word "lear". Nevertheless, further search established the fact that the word "lehr" first began to be used in the period 1890—1900 in the United States. W. R. Stewart, in an article entitled "Great Industries of the United States: 1. Glass Making", in the June 1904 issue of *Cosmopolitan,* Volume 37, p. 139, states:

> "In 1890, a novice in the plate glass industry, Henry Fleckner, of Pittsburgh, whose only knowledge of glass had been acquired in a window glass factory, invented an annealing 'lehr', the most important single improvement ever introduced in plate glass manufacture. In three hours by the lehr the same work is done which under the old kiln system required three days".

On page 148 of the same article the spelling "lehr" occurs twice.

B. F. Biser, in his *Elements of Glass and Glassmaking,* published in 1899, in Pittsburgh, Pa., states, under the title "Principles of Annealing as Applied to Glass", page 76:

> "Annealing means to heat a substance, like glass, and then allow it to cool gradually. There are at present but two successful methods of doing this: One by gradually withdrawing the glass—after being heated—from the heat; the other by allowing the source of the heat to gradually become extinct. The first is applicable generally to 'lehrs', and the latter to 'ovens'."

Two other references to the word "lehr" in the same book appear on page 75.

Although the word "lehr" thus appeared in the last decade of the nineteenth century, and its use in glass-works practice in America gained steady recognition between 1900 and 1910, American Government literature has been very chary of giving it recognition.† In the well-known *Report on the Manufacture of Glass,* by J. D. Weeks, published in New York in 1883, a report based on the *Census of Production of Glass and Glassware in the United States in 1880,* the word "leer" was consistently used. Thus, page 6, the men who looked after the annealing operation were referred to as "leer tenders", whilst on page 51, he referred to "annealing oven or leer, which is a low-arched furnace, generally of considerable length". In 1910 the U. S. Bureau of Labor, Washington, issued *A Report on the Condition of Women and Child Wage Earners in the U.S.A., Vol. III, Glass Industry.* In this publication the term still employed was "leer" and never "lehr". Indeed, this official use continued into 1927, when the U. S. Department of Labor, Washington, issued as a *Bulletin of the U. S. Bureau of Labor Statistics, No. 441,* on the *Productivity of Labor in the Glass Industry.* In numerous references spaced between pages 26 and 174, and covering bottles, pressed ware, electric-light bulbs, tumblers, window glass and plate glass, the form of the word employed is always "leer" and never "lehr".

It appears to be established that the first use of the spelling "lehr" was in the United States, and that the date of its introduction was between 1890 and 1900. It may have been used first, as stated by W. R. Stewart, by Henry Fleckner; but in a search of the patent lists Mr. Sewell reports that no mention could be found of Henry Fleckner as a patentee. The origin of the spelling, therefore, remains obscure. It is conceivable that it arose from a mis-spelling of the word "leer" hitherto commonly used in the States. The mistake could have arisen if the second "e" in "leer" had been mis-shapen so that it looked like an "h", and in that form was copied from one document to another. It is conceivable that an inventor, such as Henry Fleckner, had the idea that if he altered the spelling of the word it might give support to his claim as hav-

(*Continued on page* 44)

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*This inventor obtained two British patents for annealing devices (No. 11,465 in 1912, and No. 17,038 in 1915), and neither of them was referred to as a "lehr" or "leer."

**The information on this point was received from Mr. A. W. Kimes, the well-known Editor of the *National Glass Budget,* Pittsburgh, Pa., who kindly searched the files of his publication back to 1895.

†Mr. Herbert M. Sewell and his staff of the Toledo Public Library have been most helpful in undertaking a search of American literature between 1880 and 1910. They directed attention to the article by W. R. Stewart and to the passages in B. F. Biser. As the result of extensive searches, Mr. Sewell reported that between 1880 and 1911 the U. S. Patent Specifications listed the devices for the annealing of glass under the headings "Glass Annealing Oven, Glass Annealing Leer, Leer, Glass Leer, Glass Leer for Annealing Plate Glass, Glass Annealing Kiln, etc." The texts of these patents were read, but in no case, either in the indexes or in the text, was the spelling "lehr" noted. In the course of the search by Mr. Sewell and his staff, the following publications were checked and examined:

W. F. Poole's *Index to Periodical Literature and Supplements, 1882-1907,* Boston, Houghton, 1887-1908; *Readers' Guide to Periodical Literature, 1900*—New York; *Transactions of the American Ceramic Society, 1889-1917;* V. S. Clark, *History of Manufacturers in the United States,* New York, McGraw-Hill, 1929, 3 vols.; J. F. Ames, *Comprehensive Index to the Publications of the United States Government, 1881-1893.* Washington, Gov't. Printing Office, 1905, 2 vols.; U. S. Superintendent of Documents, *Monthly Catalogue United States Public Documents, 1895-1940.* Washington, Govt. Printing Office, 1895-1940; books on glass and glass manufacturing for the appropriate period; *Chemical Abstracts,* American Chemical Society, 1907- , Easton, Pennsylvania; *Engineering Index,* 1884- , New York; *Engineering Magazine,* 1892; United States Patent Specifications and Drawings.

INDUSTRY CONFERENCE STUDIES ACCIDENT PREVENTION

Eternal vigilance is the key to the successful operation of the accident prevention program in the refractory plant of Corning Glass Works, Corning, N. Y. So declared R. K. Smith, Manager of Corning's pot and clay division, in an address before the Glass and Ceramics Section of the National Safety Council, during the 37th annual Safety Congress in Chicago held late in 1949.

There can be no relaxation of the effort to enforce accident prevention measures, Mr. Smith insisted, for, if employees once show a tendency to let down, the accident problem will still be there in its original intensity.

The safety program in effect under his jurisdiction in the pot and clay plant, Mr. Smith declared, has paid off well. Its one objective is to reduce accidents in the plant and this, he felt, is being accomplished. Over the past five years there has been an average of only 11 lost time accidents per million man-hours worked, contrasted with an average national frequency rate of 19.53 for the industry as a whole in 1948.

"We believe our risks are far greater than the average," said Mr. Smith, and he added that this low accident rate means less time lost and lower compensation costs. In giving employees an assurance that the management has the interest of the workers at heart, the safety program, he also pointed out, has had a beneficial effect on plant morale, as indicated by the low labor turnover at Corning.

Old timers, he said, who used to think that a one-inch accumulation of dust was normal, are especially appreciative of the new order brought about by concern over their welfare and some ten percent of the payroll are men with from 25 to 48 years of service with the company.

The safety program in the pot and clay plant has no administrative director, Mr. Smith explained to the gathering of safety engineers in the glass and ceramics field, but is managed by a plant committee appointed by the director of personnel relations.

Their approach to the problem is from three directions: educational, medical and technical. Elaborating on the first phase—education—he said that by use of National Safety Council posters, which are changed once a month, attention of employees is constantly being directed to some new safety angle. Fire prevention and hazards in materials handling are presented in motion pictures, shown on company time and the plant magazine is a potent means for building morale. This is mailed to workers' homes direct where the articles calling attention to the hazards faced by the family breadwinner effectively enlist the entire family's cooperation. A safety suggestion system with money awards also encourages employees to interest themselves in elimination of accidents.

Once each month, too, Mr. Smith continued, an impartial rotating committee inspects each department and its report, with recommendations, are posted where all employees may learn what the committee has found wrong. As these are corrected by department foremen, they are removed from the month's list, but if any lack of action appears, the committee summons the department representative to a meeting for an explanation.

The medical program, Mr. Smith went on, includes a pre-employment physical examination of applicants for jobs, which not only eliminates all who might not be adapted to work anywhere in the plant but also insures that accepted newcomers will not be placed in jobs to which they are physically unsuited. The medical department includes a dispensary and hospital open 24 hours a day, and has a dentist on full time for dental service. Passes for visits to the medical center are issued to the men by the department foreman.

The technical phase of the safety program, Mr. Smith said, is, in general, designed to uncover hazards and devise means for their solution. If the inspection committee, for example, receives a complaint about too much dust in some place, this is turned over to a technician for any action indicated. If the complaint involves a hot area, the technician checks temperatures and radiant energy, determines if there is proper air movement and takes whatever corrective steps are called for. Specifically, the technical program covers six details: dust, heat, heavy lifting, machinery in motion, acid handling and fire, he said.

He described the means used for isolating inherently dusty areas from the rest of the plant so that dust can be confined to those limited sections, and also explained the centralized low velocity dust collecting system with main pipe lines to which are connected branches running to each point of dust accumulation. Portable, small capacity dust collectors are used in some spots, he said, and in special grinding rooms operators are required to wear masks.

That this elaborate system is effective, he declared, is shown by the fact that dust counts in the Corning plant show from 1.7 to 4.3 million particles per cubic foot, whereas in other plants that have no dust collecting means, he said, dust counts for comparable operations show up to 750 million particles per cubic foot.

Discussing the heavy lifting problem, Mr. Smith declared that use of pallets and lift trucks is one of the greatest single new improvements in industrial operations. Not only has it reduced physical hazards to men handling heavy loads, but at Corning it has reduced by 60 per cent the personnel required for these jobs. "That," said Mr. Smith, "is an example of the *economy* of safety. It shows how safety pays financially as well as psychologically."

Other details of his talk dealt with the protective clothing required for men in heat areas and in acid handling and also with the plant's fire protection system. The plant fire brigade of seventeen men, he stated, can get water on a blaze anywhere in the plant within seventeen seconds after the alarm is sounded.

Another speaker at the Chicago safety conference was Prof. R. M. Campbell, head of the ceramic engineering department at the New York State College of Ceramics, Alfred University, Alfred, N. Y., who made a plea for inclusion of safety engineering with other engineering instruction.

"From my observation," said Prof. Campbell, "engineering colleges very efficiently equip their students to safeguard life and property from structural failure. Much too little emphasis is placed upon safeguarding

(*Continued on page* 52)

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Feeding and Forming

Press Mold. Fig. 1. Patent No. 2,490,450. This invention by Charles H. Lysle and James M. Guthrie of Pittsburgh and Allison Park, Pa., respectively, comprises a mold 1 having an ejector or valve 4 and a plunger 2 which may be the same as shown in Patent No. 2,064,624 or Patent No. 2,287,512. A spring pressed sleeve 8 is lifted by the glass displaced by the downwardly moving plunger as is usual. The plunger is provided with a shoulder 5 which forms a corresponding shoulder on the glass being pressed and this shoulder shows the nominal capacity of the glass which will remain constant notwithstanding slight variations in the amount of glass fed to the mold. Any variation in the amount of glass delivered to the mold will vary the over-all height of the glass but will not affect the capacity as shown by the shoulder.

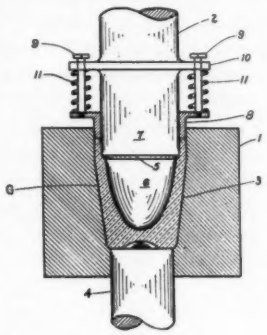


Fig. 1. Press Mold.

The following references are of record in the file of this patent: United States Patents: 85,203, Boggs, Dec. 22, 1868; 265,300, Atterbury, Oct. 3, 1882; 646,948, Brookfield et al., Apr. 10, 1900; 804,069, Strub, Nov. 7, 1905; 862,466, First, Aug. 6, 1907; 907,386, Meeker, Dec. 22, 1908; and 2,210,583, Henry, Aug. 6, 1940. Foreign Patents: 1,994, Great Britain, A. D. 1866.

Glass Compositions

Multicomponent Trivalent Metal Phosphate Glass. Patent No. 2,486,811. Assigned to Monsanto Chemical Company by Woldemar A. Weyl, this glass is intended for use in an electrical insulating material when combined with clay and flint in which this glass forms the bond.

This glass is set forth in Claim 1 as a multicomponent metaphosphate glass composed of a trivalent metal metaphosphate selected from the group consisting of $Al(PO_3)_3$ and $Fe(PO_3)_3$ together with a compound selected from the group consisting of silica and boric oxide, which is effective to lower the glass forming temperature to about 1350° C., said glass being substantially free of alkali metal compounds and containing said silica and said boric oxide in an amount equivalent to at least 5% and 4% by weight respectively.

A glass composition for the same purpose and by the same inventor was noted in our last issue.

Twenty-one United States patents and nine foreign patents are of record in the file of this patent.

Optical Glass. Fig. 2. Patent No. 2,490,331. William H. Armistead assigned this invention to Corning Glass Works and it relates particularly to glasses known as dense barium crowns.

The following glasses, which are given in per cent by weight as calculated from their respective batches, give examples which have been tried and which come within the scope of this invention:

	A	B	C	D	E
SiO_2	20	10	9	10	8
BaO	55	65	60	50	50
PbO	5	5	10	25	30
B_2O_3	15	15	17	10	10
Al_2O_3	5	5	.....	.....	2
ZrO_2	.....	.....	4	5	.....
n_D	1.6492	1.6774	1.7085	1.7774	1.7778
v	53	48	44	33	31

The figure shows a diagram representing the values of n_D for the above glasses plotted against their respective values of v as indicated by the letters.

The following references are of record in the file of this patent: United States Patents: 1,513,923, Montgomery, Nov. 4, 1924; and 2,297,453, Berger et al., Sept. 29, 1942. Foreign Patents: 388,118, Great Britain, 1933 and 596,513, Germany, 1934.

The following two inventions were published under

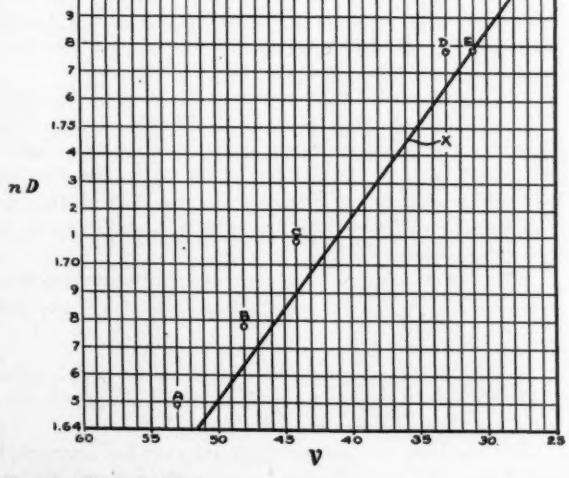


Fig. 2. Optical Glass.

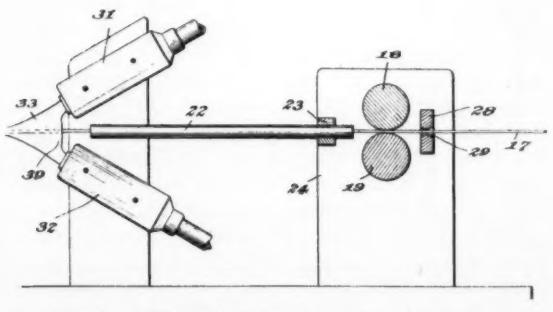


Fig. 3. Fiber Making Machine.

"Abstracts of Applications" in the Patent Office Gazette dated Dec. 6, 1949:

Barium-Beryllium-Borate Glass, Application Serial No. 689,534, Kuan-Han Sun and Maurice L. Huggins, Rochester, N. Y., assignors to Eastman Kodak Company. Filed Aug. 9, 1946. One sheet of drawings.

An optical glass comprising as its principal ingredients the oxides of barium, beryllium, and boron has a high refractive index and Abbe value and is less expensive than glasses having a high content of rare elements. The following examples are given:

	1		2		3		4		5	
	W	C	W	C	W	C	W	C	W	C
$BO_{1.5}$	35	63	20	43	35	63	25	52	28	46
BaO	60	25	68	33	50	21	50	24	39	15
BeO	5	12	5	15	5	12	5	15	5	11
CaO	.....		.....		.....		.....		28	28
$LaO_{1.5}$	.....		.....		10	4	20	9	.....	
SiO_2	.....		7	9	.....		.....		.....	
n_D	1.64		1.664		1.656		1.695		1.6598	
v	57.1		54.0		55.5		52.0		53.5	

In the above table W indicates weight, and C indicates molecular percentages.

Thorium—Free Borate Glass. Application Serial No. 700,156. Paul Francis DePaolis, Rochester, N. Y. Filed Sept. 28, 1946. No drawing.

Borate optical glasses which are free from thorium but which have optical properties reasonably close to thorium-containing glass and capable of substitution therefore in photographic objectives contain lanthanum, tantalum, boron, and zirconium oxides in substantial amounts, and in most cases barium and tungsten oxides also. In some examples other oxides such as zinc, silicon, strontium, titanium and lead oxides are added in small amounts These glasses have an index of refraction for the D line in the region between 1.73 and 1.76 and an Abbe value between 43 and 47. The following representative examples indicate the range of optical properties and choice of ingredients; the proportions of the several oxides being given by weight:

Oxide	1	2	3	4	5
La	31.7	29.5	30.9	33.0	30.45
Ta	20.1	18.6	17.1	17.0	13.85
Ba	7.9	12.5	5.7	8.	8.85
Zr	6.3	3.	6.2	5.5	4.50
Si	.....	6.	.....	.....	.20
Sr	.....	.....	.....	2.0	.....
W	.....	.....	6.8	.....	5.00
Zn	.....	.....	.....	1.0	3.50
B	34.0	30.4	33.3	33.5	33.65
n_D	1.753	1.756	1.753	1.753	1.746
v	45.2	43.9	44.6	46.7	45.5

Oxide	6	7	8	9
La	26.96	34.60	39.70	29.90
Ta	12.85	5.80	9.20	18.
Ba	9.20	18.53	6.20	7.05
Zr	4.70	4.70	5.92	5.82
Sr	.....	2.40	2.53	.....
Si	5.30	3.90	2.46	.....
W	5.98	3.27	6.96	2.60
Zn	.72	1.70	.....	.....
Al	.50	3.10	4.08	.....
Ca	1.47	.....	.....	.....
Ti	1.27	.....	.....	.....
Pb	3.00	.....	.....	.....
Na	.05	.....	.....	.33
B	28.00	22.00	22.95	35.70
n_D	1.747	1.755	1.777	1.733
v	43.8	47.2	44.7	46.3

A corresponding Belgian patent, 476,293, was granted Oct. 31, 1947.

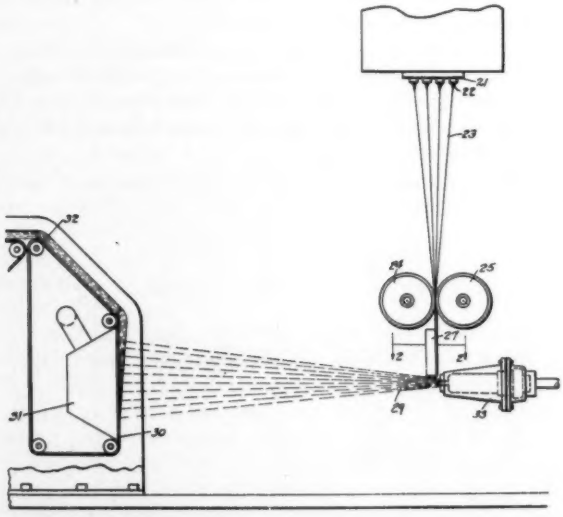


Fig. 4. Method of Making Fibers.

Glass Wool and Fiber

Fiber Making Machine, Fig. 3. Patent No. 2,489,242. Games Slayter and Ed Fletcher assigned this invention to Owens-Corning Fiberglas Corporation.

The figure shows a filament 17 which is drawn out by rolls 18 and 19. On the incoming side of the rolls is a guide plate 28 and on the outgoing side is a tube 22. It is to be understood that the machine comprises a row of units of which one is shown here.

As the filament leaves the tube 22 it enters the high temperature and high pressure blast from burners 31 and 32. The temperature should be from 2500 to 3000° F., and the velocity of the blast about 500 to 700 feet per second or even more. This softens the glass and draws out very fine fibers which are collected into a mat on a suitable conveyor.

The patent contains 13 claims and 16 references were cited by the Patent Office including 13 U. S. patents and three foreign.

Method of Making Fibers. Fig. 4. Patent No. 2,489,-243. Charles J. Stalego assigned this invention to Owens-Corning Fiberglas Corporation.

The machine for carrying out this method comprises a bushing 21 from which a number of filaments 23 are

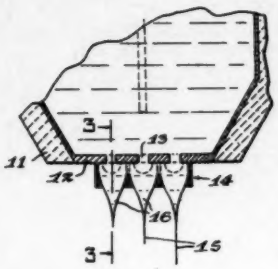


Fig. 5. Apparatus for Making Fibers.

drawn out by rollers 24 and 25. From the rollers the filaments pass through a guide 27 which has a series of vertical grooves to keep the filaments separated. The filaments then enter a very hot blast 29 from a burner 33 which blows the fibers onto a conveyor 30 backed up by a suction box 31 causing a mat 32 to be formed on the upwardly moving conveyor.

This apparatus has some similarity to that shown in Patent No. 2,481,543 noted in the October 1949 issue of THE GLASS INDUSTRY by the same inventor. The patent contains 21 claims and the following references are of record in the Patent Office file: United States Patents: 1,008,204, Seghers, Nov. 7, 1911; 1,049,314, Neil, Dec. 31, 1912; 1,157,984, Herkenrath, Oct. 26, 1915; 1,689,551, Hammond Oct. 30 1928; 2,068,203, Simpson, Jan. 19, 1937; 2,133,235, Slayter, Oct. 11, 1938; 2,133,238, Slayter, Oct. 11, 1938; 2,175,225, Slayter, Oct. 10, 1939; 2,228,150, Norman, Jr., Jan. 7, 1941; 2,291,289, Slayter et al., July 28, 1942; and 2,335,135, Staelin, Nov. 23, 1943.

Apparatus for Making Fibers. Fig. 5. Patent No. 2,489,508. This is another patent assigned to Owens-Corning Fiberglas Corporation by Charles J. Stalego. The invention relates particularly to the bushing from which the molten glass is discharged and the figure shows this bushing at 11 as composed of a metallic lining enclosed on the sides by refractory material and having a bottom 12 provided with a multiplicity of orifices 13. The bottom of these orifices is surrounded by what is called a "tip" 14 formed of a thin metal sheet, preferably the same as that from which the bottom 12 is made. This may take the form of sort of a honeycomb structure as viewed from below enclosing each orifice. The glass will wet the upper hotter walls of this tip but will not adhere to the cooler lower walls. The glass may be pulled or drawn by any desired mechanism to form fibers 15.

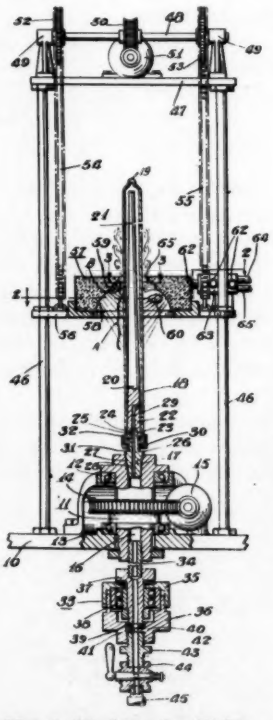


Fig. 6. Machine for Making Precision-Bore Tubes.

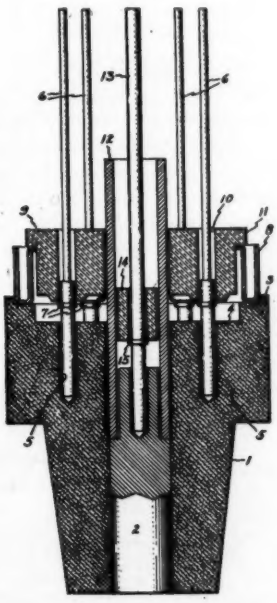


Fig. 8. Glass-to-Metal Seal.

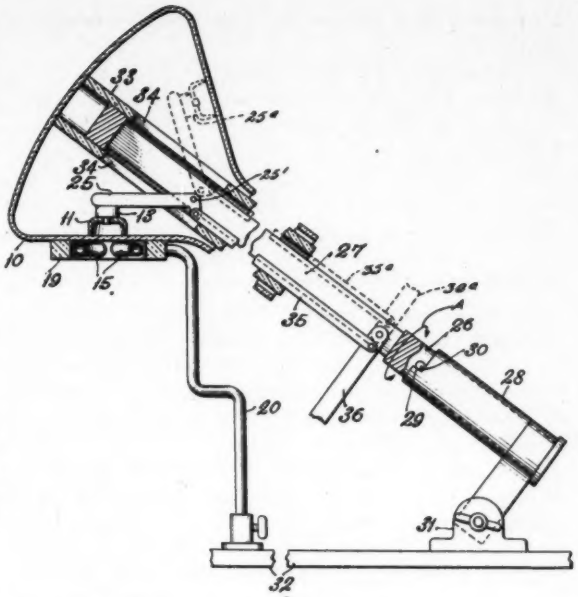


Fig. 7. Inserting Contacts in Glass Tubes.

The references of record in the file of this patent are Patent No. 1,796,571 granted to Mathieu on Mar. 17, 1931 and 2,229,489 granted to Barnard on Jan. 21, 1941.

Tube and Cane Machines

Machine for Making Precision-Bore Tubes. Fig. 6. Patent No. 2,490,252. Nathaniel Brewer assigned this invention to Fischer & Porter Company of Hatboro, Pa.

The figure shows the machine arranged to form a tapered tube having exact inside measurements, from a generally cylindrical tube 18. A mandrel 20 determines the diameter to be given to the inside of the tube. A rotatable head has an air-tight connection with the tube and also carries the mandrel 20. Vacuum connections to the inside of the tube are provided through the center and lower part of the mandrel and are under the control of a three-way valve 44 by which air under pressure or at atmospheric pressure may be admitted to the inside of the tube.

A heating element 57 of refractory material has three tangentially arranged burners 60 and the element is arranged to be moved vertically by connections to a motor 51. The upper end of the tube 18 is sealed at 19 so that when a vacuum is applied to the inside of the tube, which is at the same time softened by the gradual lowering of the heater 57, the tube will progressively collapse upon the mandrel. The heater is constructed so as to apply greater heat near its top surface and thus gradually bring the glass to the softening point as the heater descends. When the tube is completed, compressed

air is admitted to the interior to assist in the removal of the tube.

The following references are of record in the file of this patent: United States Patents: 786,259, Bournique, Apr. 4, 1905; 790,265, Sassman, May 16, 1905; 911,373, Brinkman, Feb. 2, 1909; 1,301,714, Keuppers, Apr. 22, 1919; 1,446,026, Wetmore, Feb. 20, 1923; 2,254,306, Mott et al., Sept. 2, 1941; and 2,286,401, Everett, June 16, 1942.

Miscellaneous Processes

Inserting Contacts in Glass Tubes. Fig. 7. Patent No. 2,485,769. George N. Phelps assigned this invention to Radio Corporation of America. It relates particularly to making a hole in the wall of a cathode ray tube such as shown in Patent No. 2,323,148 to McLaughlin and sealing a metal disc into the wall.

The figure shows a cathode ray tube 10 in position to be pierced by a punch 11. The glass opposite the punch is heated by an induction coil 15. The punch is actuated by a slide rod 35 connected to a handle 36. A suitable fixture is provided to hold the tube and working parts. The metal disc of suitable material is inserted into the hole thus formed while the glass is still soft and by proper manipulation a good glass-to-metal seal is formed.

The following references are of record in the file of this patent: United States Patents: 810,474, Doane, Jan. 23, 1906; 1,722,010, Littleton et al., July 23, 1929; and 2,374,706, Saslow, May 1, 1945.

Lamp Making Machine. Patent No. 2,486,085. Westinghouse Electric Corporation acquired this invention from James B. Whitmore and Louis D. Morand. The machine is an improvement over that shown in Patents No. 1,210,237 and 1,210,238 to Walker and is particularly adapted for applying the bases to lamps of the "mogul" or "Three-lite" type.

The machine is of the turret type having 24 heads which pass successively through a series of working stations where the several contact rings are positioned on the lamp bulb and secured in position with the usual molten glass.

There are 18 figures in the patent and as the machine is rather complicated, it is difficult to find any one view which will give a general idea of the invention. Any one interested in machines of this type should make a study of the complete patent.

The following references are of record in the file of this patent: United States Patents: 1,210,238, Walker et al., Dec. 26, 1916; 1,227,244, Buhles, May 22, 1917; 1,536,740, Akeroyd, May 5, 1925; 1,712,670, Madden, May 14, 1929; 1,826,505, Conn., Oct. 6, 1931; 1,990,258, Trutner, Feb. 5, 1935; 2,120,877, Uber, June 14, 1938; and 2,157,051, Birdseye, May 2, 1939.

Glass-to-Metal Seal. Fig. 8. Patent No. 2,486,101. General Electric Company acquired this invention from James E. Beggs.

According to the patent, the parts of a header for an electric discharge device are assembled in a fixture having a graphite body 1 and a metal insert 2 suitable holes being provided to support these parts. The glass body 9 for the header and the central bead 14 are heated so as to seal the parts together. After forming the seal, the parts may be removed from the fixture and subjected to an annealing treatment. The device is well adapted for automatic handling while carried on a conveyor through heating and annealing ovens.

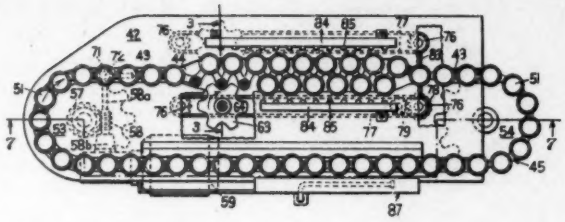


Fig. 9. Glazing Machine.

The following references are of record in the file of this patent: Foreign Patents: 2,078,776, Ruggles, Apr. 27, 1937; and 2,125,315, Ronci, Aug. 2, 1938.

Glazing Machine. Fig. 9. Patent No. 2,487,355. William L. McNamara and Frederick Z. Fouse assigned this invention to Anchor Hocking Glass Corporation. While the invention relates particularly to glazing machines, certain features may be used in conveyors for other purposes.

The figure is a plan view of the machine and it shows a table 42 provided with a track having a narrow portion 43 which branches to form a wide portion 44. This track serves as a guideway for a conveyor 45 which is driven by a sprocket 53 at the left end and passes around an idle sprocket 54 at the other end. At the entrance to the wide portion of the track, a "booster" sprocket causes the links of the conveyor to fold so as to form two rows of the ware being conveyed which, of course, slows down the linear speed. During this portion of the track, burners 84 perform the glazing operation. Later the conveyor again puts the ware in single file. Means is provided for rotating the ware during the heat treatment.

The following references are of record in the file of this patent: United States Patents: 914,188, Robinson, Mar. 2, 1909; 1,557,368, Kershaw et al., Oct. 13, 1925; 2,368,350, Ellison, Jan. 30, 1945; 2,393,521, Duncan et al., Jan. 22, 1946; and 1,856,498, Miller, May 3, 1932.

Ware Conveyor. Fig. 10. Patent No. 2,487,354. Patent No. 2,478,355, which was reviewed in our last issue, was divided from this application and the disclosure is quite similar. The former patent showed the conveyor of the present patent adapted for use in a glazing machine while the present patent claims the conveyor broadly. Both patents in question were invented by William L. McNamara and Frederick Z. Fouse and assigned to Anchor Hocking Glass Corporation.

As shown in the figure, this patent comprises a pair of sprockets around which passes an endless conveyor traveling in a track so that the articles are in single file

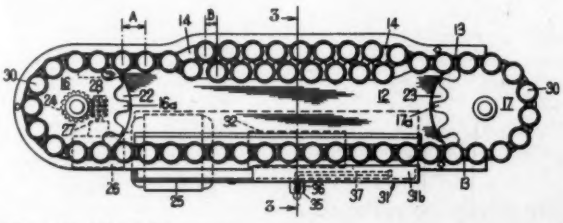


Fig. 10. Ware Conveyor.

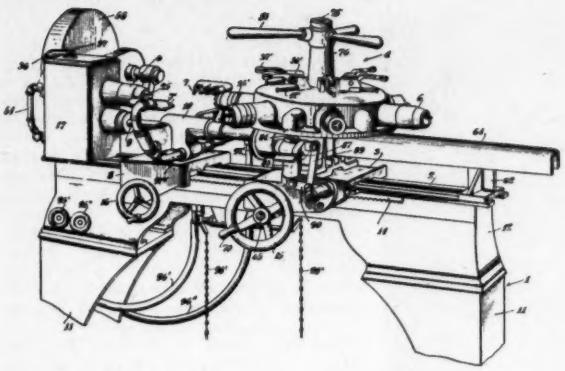


Fig. 11. Machine for Assembling Radio Tubes.

until they reach a wide portion 14 of the track. At this point the chain conveyor doubles up so as to carry the articles in a double file while being subjected to any desired treatment such as, for example, glazing. The chain conveyor thereafter straightens out so that the articles return to single file. Various adjustments are provided so as to keep the chain under proper tension and so forth.

The following references are of record in the file of this patent: United States Patents: 1,540,021, Knight, June 2, 1925; 1,557,368, Kershaw et al., Oct. 13, 1925; 1,768,482, Koch, June 24, 1930; 1,856,863, Clark, May 3, 1932; and 2,174,241, Grotzinger, Sept. 26, 1939.

Machine for Assembling Radio Tubes. Fig. 11. Patent No. 2,488,126. This patent, which includes three sheets of drawings, was assigned to Kahle Engineering Company of North Bergen, N. J. It is the invention of Louis C. Kahle.

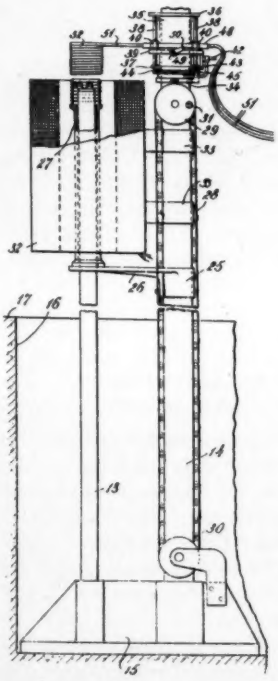


Fig. 12. Glass-to-Metal Sealing Machine.

The figure shows a table 12 on which a turret 4 is movable to and from a work holder 5. Burners 7 are mounted on a carriage 8 also movable to and from the work. One of the parts to be joined together is positioned in the fingers 25 of the work holder and the other parts are mounted on the holders 6 of the turret. The turret is then advanced to bring the two parts together while they are heated by the burners 7. The turret is then retracted and turned to bring the next part into operative position. This operation is repeated until the article has been built up. Various changes may be made to accommodate certain articles.

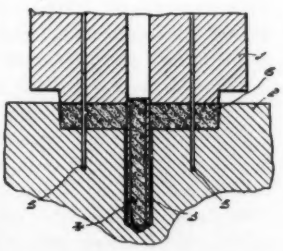


Fig. 13. Making Exhaust Tubes for Lamps.

There are 14 U. S. patents cited by the Examiner during the prosecution of this application and also one foreign patent.

Glass-to-Metal Sealing Machine. Fig. 12. Patent No. 2,488,302. This invention by Raymond R. Machlett and Joseph W Skehan was assigned to Machlett Laboratories, Incorporated of Springdale, Conn. One use of the invention is in the manufacture of electron tubes as shown in Patent No. 2,376,439 to the same inventors.

The machine is supported in a pit on columns 13 and 14. The column 14 has an arm carrying a sleeve 27 to support the work. This sleeve is vertically adjustable by a chain operated by a handle 31. The upper end of the column 13 carries means for positioning the metal side discs which are to be sealed to intermediate glass spacers. The work is surrounded by an electric annealing oven 32 and the work is heated by a high frequency coil 52.

In the use of this device, a disc placed on the sleeve 27 is heated so as to fuse it to an adjacent glass ring by lowering the heating coil 52. Then the sleeve is lowered and another disc and glass ring are placed on top of the first when the operation is repeated. This process is continued until the article is complete and it is then annealed by the oven 32.

The following references are of record in the file of this patent: United States Patents: 1,904,214, Fagan, Apr. 18, 1933; 2,048,556, McArthur, July 21, 1936; 2,121,627, Donovan et al., June 21, 1938; 2,125,316, Ronci, Aug. 2, 1938; 2,191,951, Blau, Feb. 27, 1940; 2,290,050, Hinkley et al., July 14, 1942; 2,296,347, Hinkley et al., Sept. 22, 1942; 2,297,492, Michaelis, Sept. 29, 1942; 2,335,617, Thomas et al., Nov. 30, 1943; 2,359,501, White, Oct. 3, 1944; and 2,374,546, Laico, Apr. 24, 1945.

Making Exhaust Tubes for Lamps. Fig. 13. Patent No. 2,490,528. Hendricus J. Lemmens of Eindhoven, Netherlands, assigned this invention to Hartford National Bank and Trust Company. It relates to the manufacture of bottom discs for incandescent lamps or electric discharge tubes having exhaust tubes attached to the bottom.

The figure shows an upper mold or plunger 1 and a lower mold 2 having a central opening to receive a tube 3 and other openings to receive rods 5. The tube has been filled with sand or other powdered material 4. The remaining cavity in the mold is then filled with powdered glass 6 which is heated and then pressed to form by the plunger. The article thus formed comprises at least 5 per cent of finely distributed cavities. The sand is removed by rapping the tube after which the end may be cut off to provide an opening.

The following references are of record in the file of this patent: United States Patents: 1,923,148, Hotchner, Aug. 22, 1933; 2,030,185, Rose, Feb. 11, 1936; and 2,347,421, Little, Apr. 25, 1944.

Electrode for Electric Melting of Glass. Fig. 14. Patent No. 2,490,825. Corning Glass Works acquired this invention from John M. Mochel. This refractory compo-

(*Continued on page* 54)

Glass Crafts of America's Board of Directors meeting at Wheeling, West Virginia, outlining plans for cooperation with U. S. Department of the Interior, National Parks Service, in the Jamestown glasshouse project. Seated, left to right, W. F. Dalzell, Chairman; Helen V. Denson, Public Relations Counselor; William G. Muhleman, Vice Chairman; H. L. Dillingham, Secretary; and T. Clarence Heisey, member of Executive Committee. Standing, left to right, are: Carl W. Gustkey, Treasurer; William F. McCartney, Executive Committee; C. T. Swartling, John C. Weber, Jr., and Henry E. Payne, all members of Executive Committee; and Erwin M. Frey, Public Relations Counselor.

GLASS CRAFTS SETS UP PROGRAM TO TRACE AMERICAN GLASSMAKING

Glass Crafts of America, trade association of producers of handmade American glassware, has announced the start of a long-range program, which will be carried out in cooperation with the U. S. Department of the Interior, to establish tangible evidence of glassmaking as America's first industry in Jamestown, Virginia, in 1608.

Evidence that glassmaking began in America 342 years ago has already been uncovered and this fact will further heighten the prestige of handmade American glassware and will add to the lore that has already stimulated the collection of American handmade glassware as a hobby.

The program was conceived as a move to help retailers increase their sales and it is expected that before the fall selling season begins, the authentic history of America's earliest glassmaking will be placed in the hands of every glassware retailer. This will be bolstered by continued repetition of the story at the consumer level.

J. C. Harrington, archeologist of the National Park Service, Department of the Interior, has been doing a great deal of work studying an excavation and glasshouse site which was discovered in 1931 at Jamestown. In cooperation with the National Park Service, Glass Crafts of America is sending Mr. Harrington to England to augment his findings. He will study original records of the Virginia Company of London which, in October, 1608, sent craftsmen to the Jamestown Colony to make glass. Mr. Harrington expects that his study of records in England will definitely reveal the kinds of glassware created in the centuries-old glasshouse at Jamestown and permit him to classify the thousands of bits of glass that have been uncovered on the site. In addition to the glass fragments, the excavations at Jamestown unearthed remains of four stone furnaces, fragments of several clay melting pots and other objects used in glassmaking.

Mr. Harrington's trip to England has as its purpose the complete reconstruction of the Jamestown glassmaking activities. Information is sought on the number of people employed in the Jamestown glasshouse, their products, their methods, the wages they received, hours and seasons worked, their plant and the dress, vocabulary, tools and materials used by the glassworkers. When this information is compiled, it will be incorporated in a detailed authentic history of earliest glassmaking efforts in America and placed in the hands of all glassware retailers and the public, clubs, schools, etc.

The Glass Crafts committee in charge of this industrial cooperation with the National Parks Service, of which Newton B. Drury is Director, is: T. Clarence Heisey, President of A. H. Heisey & Company; W. F. Dalzell, President of Fostoria Glass Company; and Carl Gustkey, President of Imperial Glass Corporation.

Members of Glass Crafts of America include Cambridge Glass Company, Fostoria Glass Company, A. H. Heisey & Company, Imperial Glass Corporation, Indiana Glass Company, Morgantown Glassware Guild, Seneca Glass Company, Westmoreland Glass Company, West Virginia Glass Specialty Company, Dunbar Glass Corporation, Viking Glass Company, McBride Glass Company and others, as well as the American Flint Glass Workers' Union.

AMERICAN WINDOW GLASS ELECTS DIRECTOR

The American Window Glass Company has announced the election of Oscar N. Lindahl to the Board of Directors. Mr. Lindahl retired as Financial Vice President of Carnegie-Illinois Steel Corporation last June and now serves as Executive Director of the General State Authority of Pennsylvania.

Mr. Lindahl entered the employ of the Illinois Steel Company in 1907 and in 1911, joined the Universal Atlas Cement Company where he served thirty years as Comptroller, Secretary and Director. In 1941, he was elected a Director and Vice President in Charge of Finance of the Carnegie-Illinois Steel Corporation.

L-O-F SEES CONTINUED GOOD BUSINESS FOR FLAT GLASS

The current high volume of business in the flat glass industry will carry well into 1950, it is indicated by the order books, and general economic factors point to good business throughout 1950, according to John D. Biggers, President of Libbey-Owens Ford Glass Company. Judging by preliminary reports on sales volume of L-O-F, it is indicated that the industry may surpass by 15 per cent its record year of 1948.

Optimism among glass men is based on the enthusiastic acceptance of larger safety glass areas in motor cars and the same trend towards larger windows in building construction.

GJ Research Digest

Effects of Major and Some Minor Constituents on Glass Melting

The effects of the major and some minor constituents on the melting and fining characteristics of amber and flint container glasses have been investigated and reported by Enright, Marshall and Poole (*Journal of the American Ceramic Society*, November 1949). The testing procedures used were unique in that 40-lb. melts were made and the results were found to be applicable to the operation of continuous glass tanks. The original paper should be consulted for the experimental details as the following condensation deals only with the end results of this investigation.

The substitution of silica for soda increased the scumming tendency and seed count of a glass. A 15% soda glass (SiO_2 72.75, Na_2O 15.0, CaO 10.0, Al_2O_3 2.0, F_2 0.25) had no scum, but by decreasing the soda content to 12.5% and increasing the silica, the scum became heavy. For the same change in composition, the seed count varied from 0 to 40 seeds per unit volume. A sharp decrease was noted in the seed count at 13.0% soda.

Very little change occurred in the scumming tendency of a glass by the substitution of alumina for soda in the range 1.4 to 2.4% alumina and 14.15 to 13.15% soda (base glass: SiO_2 74.2, Na_2O 14.15, CaO 10.0, Al_2O_3 1.4, F_2 0.25). The seed count for glasses of the same composition range increased from 5 to 40 seeds per unit volume.

The substitution of alumina for silica within the range 73.85 to 72.85% silica and 1.4 to 2.4% alumina (base glass: SiO_2 73.85, Na_2O 13.5, CaO 11.0, Al_2O_3 1.4, F_2 0.25) produced a minimum in seed count and in the scumming tendency of the glass at 2.0 to 2.2% alumina.

The replacement of lime by soda in the range 13.15 to 14.15% soda and 10.4 to 9.4% lime (base glass: SiO_2 74.2, Na_2O 13.15, CaO 10.4, Al_2O_3 2.0, F_2 0.25) had no effect on the seed count of the glass, but the scumming tendency was decreased.

When silica was substituted for lime, the results of this substitution showed an increase in seeds when the silica content was greater than 73.75% (base glass: SiO_2 73.25, Na_2O 13.5, CaO 11.0, Al_2O_3 2.0, F_2 0.25). The minimum in the scumming tendency at a lime content of about 10.25 appears to be actual because it has been observed in a number of instances at this lime content.

The effects of substituting alumina for lime were studied between the range 11.6 to 10.6% lime and 1.4 to 2.4% alumina (base glass: SiO_2 73.25, Na_2O 13.5, CaO 11.6, Al_2O_3 1.4, F_2 0.25). It was found that the substitution of alumina for lime decreased the scumming tendency. It was also found that the seed count reached a minimum point at 11.0% lime and 2.0% alumina. This effect was also noted in several cases in which alumina was the common variable. Therefore, the minimum effect was attributed to the alumina content.

The lime was replaced by magnesia in the range 11.0 to 6.6% lime and 0.0 to 4.4% magnesia (base glass: SiO_2 72.3, Na_2O 13.6, CaO 11.0, Al_2O_3 2.0, F_2 0.25). The fining time was shortened by the substitution of magnesia for lime. In the dolomitic glasses, batch stones and severe scumming were noted at temperatures above 2500°F. The viscosity of the glass at low temperatures was decreased by the substitution of magnesia for lime.

In the case of minor constituents, a study of their effects on glass melting was made on container glasses within the following composition range: SiO_2 71 to 73, Na_2O 13 to 15, CaO 9 to 12, and Al_2O_3 15 to 2.5%.

The role of fluorine as a minor constituent of glass seems to be important since small percentages bring about considerable changes in the melting properties of a glass. Fluorine decreased the fining time and the low temperature viscosity. Slag, fluobarytes and fluorspar were used as sources of fluorine. Although fluobarytes appeared to be very effective, the glasses in which it was used seemed to have a greater tendency to scum, especially at lower temperatures. The scum disappeared before the fining was completed. The results showed that the glass containing fluobarytes had a shorter fining time than one containing fluorspar and that the difference in fining time was reduced as the temperature was decreased.

Experiments showed the optimum SO_3 content to be 0.3% in the glass. Below 0.3% sulfate, the glass was poorly fined; above this amount, a considerable increase in batch stones was noted. In the case of excessive scumming, an increase in sulfate, as saltcake, successfully eliminated the scum.

The form of sulfate introduced into the batch had little effect. Fining studies showed that glasses in which the sulfate content was supplied by calcium sulfate were fined slightly faster than those in which the sulfate was supplied by barytes. At low temperatures, the viscosity of the glass containing calcium sulfate was greater than that of the glass containing barium sulfate.

Additions of barium oxide decrease the fining time, but the decrease is very small at high temperatures and is greatest at low temperatures. When barium oxide was substituted for silica, a decrease was noted in the viscosity of the glass. At low temperatures, the effect was very small; i.e., the softening point was lowered 1.8°F. by the substitution of 0.5% BaO for silica. When lime was replaced by barium oxide, the viscosity of the glass was decreased at low temperatures. The fining-time curve for these glasses showed that there was little difference between the fining time of the glass in which barium oxide was substituted for lime or silica at 2650°F. As the temperature was decreased, the barium oxide-for-lime glass showed an increasingly shorter fining time than the barium oxide-for-silica glass.

As a result of these investigations, it was concluded that in the case of the major oxide constituents: 1) an increase in silica increased the scumming tendency but decreased or increased the seed count, depending upon the type of substitution; 2) many of the properties influenced by alumina tended to pass through a reversal with increasing amounts of alumina. Above 2.3% alumina, the melting and fining rates were decreased; 3)

(*Continued on page* 40)

CORNING TO CONSTRUCT NEW PILOT PLANT

Further expansion of Corning Glass Works' research and development facilities through the construction of a new pilot plant and a new engineering building in Corning has been announced.

The pilot plant will be the first of its kind in the glass industry, being a complete manufacturing unit designed and engineered especially for pilot plant purposes. It will be equipped with a 60-ton glass melting tank and various types of conventional and experimental glass forming and finishing machines. These new facilities will make it possible to study and improve complex new processes under full-scale production conditions before they are turned over to the company's manufacturing plants. The plant will be used initially for the development of new production methods for television bulbs, but will be used later for improving the manufacture of other products.

The pilot plant building will be a two-storied structure, 320 feet long and 80 feet wide, with a total floor area of 51,200 square feet. At the start, 115 people will be employed, 25 per cent of whom will be engineers.

The new engineering building will house a new machine shop and a machine development shop on the first floor, and offices and drafting rooms for the company's Mechanical Development Department on the second. The new machine shop will centralize the company's mold making operations. It will include the most modern lathes and milling machines, all of which have been selected after careful research by the company's Engineering Department.

PERSONNEL CHANGES AT ARMSTRONG

A number of personnel changes in the sales organization of Armstrong Cork Company Glass and Closure Division, have been announced by R. H. Hetzel, General Sales Manager.

W. H. Nenstiel, formerly with the San Francisco District Office, has been transferred to Lancaster to serve as Administrative Assistant to G. M. Scattergood, Manager, Drug Sundries Department.

At the same time, I. B. Callman, formerly resident salesman in Washington, D. C., has been transferred to the New York City District, and A. E. Wells of the Cincinnati office has been transferred to the Chicago District Office.

Five new members of the Glass and Closure Sales organization have completed training at Lancaster and have been assigned to the company's district offices. E. E. Long has been assigned to Cincinnati, R. P. Haun to the San Francisco District Office, D. L. Neighbors to the Baltimore District Office, W. G. Christensen to the New York District Office, and N. F. Dial, Jr., to the St. Louis District Office.

OWENS-ILLINOIS APPOINTMENT

The appointment of Robert Malone as head of development and pricing of new designs and special items for the Libbey Glass Division of Owens-Illinois Glass Company.

Mr. Malone, who joined Libbey in 1946, succeeds Ralph R. Sutter who has been named Manager of a new Libbey branch in St. Louis.

LACLEDE-CHRISTY BUYS COLORADO PLANT

Laclede-Christy Company has announced the acquisition of the capital stock of Diamond Fire Brick Company of Canon City, Colorado, giving it its fourteenth manufacturing unit, of which it now owns eight and is affiliated with six.

The acquisition was consummated largely through a cash transaction. The controlling interest formerly was held by American Arch Company of New York, which is being liquidated. The new plant produces fire clay brick and silica brick.

J. L. Cummings of Pittsburgh has been elected Executive Vice President and D. M. Rice of St. Louis has been elected Vice President and General Manager.

LYNCH MAKES DEVELOPMENT ENGINEERING APPOINTMENT

B. Herbert Koob has recently been assigned to a position in the engineering department of Lynch Corporation, Glass Machinery Division, with headquarters in Anderson, Indiana.

Mr. Koob has been assigned to development work on Lynch automatic glass forming machines. Among other things, he is well versed in "paste mold" machinery, as he was active in much of the practical development on the No. 28 machine of the Hartford-Empire Company, with which firm he was recently associated for over eighteen years as a development engineer.

Mr. Koob has also been associated with Corning Glass Works as a development engineer, with Whitall-Tatum Glass Company as chief engineer and with the United Bottle Machine Company in bottle machine design.

CANADIAN GLASS NEWS

Rich deposits of large quantities of fine, white silica sand and bluish-gray clay may pave the way for a glassmaking industry in Manitoba, Canada, where there is also on the site a surface coal mine. The property is at Pine River, about 50 miles northwest of Dauphin, Manitoba.

A master glassmaker from Rennes, France, E. Rault, has purchased some land in the Swift Current area of Canada. He has adopted ultramodern business techniques to one of the oldest forms of artistic expression since his craft of making delicate stained glass windows is much the same as carried on 1,000 years ago. He has heavy Canadian commitments and the destruction of thousands of stained glass windows in Europe in World War II has contributed to the need for his craft.

Hobbs Glass Limited, of London, Ont., will construct a $100,000 warehouse and office in Edmonton, Alberta. It will be a one-story structure and basement on a Canadian National Railways trackage site bought early this year.

• Andrew G. Doll, Vice President of Lynch Corporation, has departed for a visit of glass manufacturers in South America. During his trip, Mr. Doll will visit Puerto Rico, Venezuela, Brazil, Uruguay, Argentine, Chile, Bolivia, Peru and Colombia. Mr. Doll expects to return to Indiana about the end of April and will then depart for Europe on June 8.

CURRENT STATISTICAL POSITION OF GLASS

Employment and payrolls: At the close of the month of October 1949, the preliminary figure for employment in the glass industry was 107,400. This is only slightly above September's revised figure of 106,700.

Payrolls for the month of October were $26,136,864. This represents an increase of about 1 per cent over the revised payrolls of $25,874,039 reported for September.

Glass container production, based on figures released by the Bureau of Census, was reported to be 7,374,851 gross for the month of November 1949. This is close to 11 per cent below the previous month's production of 8,283,420 gross, but slightly above production for November 1948 which was 7,312,507 gross. Total glass container production thus far in 1949 has reached 83,791,712 gross, as compared with 91,997,844 gross produced at the close of the same period in 1948—a difference of almost 9 per cent.

Shipments of glass containers for the month of November 1949 were 7,196,984 gross. This is a decrease of 9 per cent from the previous month's 7,945,729 gross shipments. During November 1948, shipments were 6,709,729 gross. This is 7 per cent below November 1949 shipments. Total glass container shipments at the close of the first eleven months of 1949 have reached 83,144,002 gross. This is about 8½ per cent below the 90,906,836 gross shipped during the corresponding period in 1948.

Stocks on hand at the close of November 1949 were 8,680,951 gross, as compared with 8,601,979 gross on hand at the close of October and 8,280,777 gross on hand at the close of November 1948.

Automatic tumbler production for the month of November 1949 fell off 10½ per cent to reach 4,939,817 dozens. This is a decrease from production during October of 5,521,215 dozens. Production during November 1948 was 5,398,091 dozens. Shipments for November also fell off and were reported to be 4,961,121 dozens in comparison with 5,436,365 dozens shipped during October. Shipments during November 1948 were 4,873,089 dozens. Stocks on hand at the close of November 1949 were 7,614,621 dozens, as compared with 7,676,420 dozens on hand at the close of October and 7,662,498 dozens on hand at the close of November 1948.

Table, kitchen and household: Manufacturers' sales of machine-made table, kitchen and household glassware during November 1949 was 3,647,448 dozens. This is 4 per cent below the previous month's sales of 3,801,002 dozens. Sales during November 1948 were 3,225,191. Total manufacturers' sales during the 12-month period ending November 1949 are 39,426,468 dozens, as compared with 41,683,418 dozens sold during the corresponding period in 1948.

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

	November 1949
Narrow Neck Containers	
Foods	638,452
Medicinal & Health Supplies	1,029,866
Chemicals, Household & Industrial	528,144
Beverages, Returnable	175,501
Beverages, Non-returnable	.....
Beer, Returnable	107,856
Beer, Non-returnable	195,909
Liquors	857,351
Wines	369,395
Toiletries & Cosmetics	473,332
Sub-total (Narrow)	4,375,806
Wide Mouth Containers	
Foods	*1,775,576
Dairy Products	254,781
Home Canning	.....
Medicinal & Health Supplies	264,993
Chemicals, Household & Industrial	81,417
Toiletries & Cosmetics	119,572
Packers' Tumblers	90,635
Sub-total (Wide)	2,586,974
Total Domestic	6,962,780
Export Shipments	234,204
Total Shipments	7,196,984

* This figure includes Home Canning.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production November 1949	Stocks November 1949
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	*2,808,601	3,026,337
	Wide Mouth	2,386,819	2,334,089
Dairy Products		262,323	250,194
Home Canning		.....	397,696
Beverages, Returnable		**249,600	682,206
Beverages, Non-returnable		.....	9,608
Beer, Returnable		108,509	560,560
Beer, Non-returnable		191,083	286,539
Liquors		886,874	735,799
Wines		387,556	293,889
Packers' Tumblers		93,486	104,034
Total		7,374,851	8,680,951

* This figure includes Home Canning.
** This figure includes Beverages, Non-returnable.

PILKINGTON BROTHERS TO RESUME SHEET GLASS PRODUCTION

Pilkington Brothers Limited has announced plans to resume the manufacture of sheet glass in Canada to meet increased requirements there. A site of about 33 acres has been obtained at St. Helens where work is expected to start in the near future.

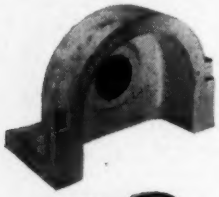
Upon completion, the plant which adjoins a spur of the Canadian National Railway will have about 1½ miles of railway sidings, service roads and side railways, and when in full production, it is estimated that employment will be available for about 300 men.

PREMIUM PERFORMANCE
Without Premium Price

CRYSTALITE (mullite-bonded mullite) feeder parts now at a new lower price, offer a new 3-way cut into rising glass production costs.

- New lower price
- Same high crystaline bond for longer life
- Same close tolerance dimension accuracy

Specify **REMMEY CRYSTALITE,** the premium performance mullite . . . reduce costs 3 ways!

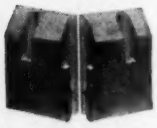


BONUS-BUILDING SPOUTS
Long-lived, firm closure at tube seat . . . close-tolerance machined for uniformly accurate location in feeder.

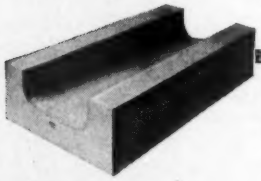
BONUS-BUILDING TUBES
High refractoriness and erosion resistance assure enduring firm closure at tube seat . . . and thorough agitation.

BONUS-BUILDING PLUNGERS
Retain shape longer for continued, more accurate control of glass gob.

BONUS-BUILDING ORIFICE RINGS—Retain shape and size for longer runs without costly replacement shutdowns.



BONUS-BUILDING BURNER BLOCK—Accuracy of dimension for quick, hairline matching to burners.



BONUS-BUILDING CHANNELS
Uniformity, accuracy, and structural quality combine for longer productive life.

REMMEY

Dependable Refractories

RICHARD C. REMMEY SON CO.

Philadelphia 37 • Pennsylvania

RESEARCH DIGEST . . .

(*Continued from page* 37)

When lime was substituted for silica, slight changes were noted in the fining and scumming characteristics of the glass. Changes in lime content showed less effect than any other oxide on the melting and fining properties of the glass; 4) The substitution of magnesia for lime shortened the fining time, but increased the scumming tendency. Magnesia decreased the viscosity of the glass at low temperatures; 5) An increase in soda greatly improved the melting, fining and scumming properties of a glass.

In the case of the minor oxide constituents, it was concluded that: 1) fluorine decreased the fining time of a glass but increased the tendency to scum. The viscosity of the glass was decreased by the addition of fluorine; 2) Sulfates decreased the tendency of a glass to scum and improved the fining properties; 3) Barium oxide had its most beneficial effects below 2650°F. At low temperatures, barium oxide decreased the fining time of a glass. However, at high temperatures, the decrease was very small. The substitution of barium oxide for silica slightly reduced the viscosity of the glass at low temperatures; when substituted for magnesia or lime, a greater decrease was noted. Barium oxide was most effective when substited for lime or magnesia.

STUART M. PHELPS TO RECEIVE BLEININGER AWARD

At a recent meeting of the Pittsburgh Section of the American Ceramic Society, it was announced that Stuart M. Phelps, Senior Fellow, Mellon Institute, and Director of Research and Tests, American Refractories Institute, has been chosen as the recipient of the 1950 Albert Victor Bleininger Award, conferred for "distinguished achievement in the field of ceramics". The award, which consists of a medal and scroll, will be presented to Mr. Phelps at a dinner to be given in his honor at the Hotel Schenley on March 10, 1950.

Throughout his professional career, Mr. Phelps has been associated with Mellon Institute to which he came in 1917 as a laboratory assistant. In 1918 he was appointed to the Refractories Fellowship, becoming Senior Fellow in 1926. Since that time, he has been in charge of the fellowship's program of research and testing.

CHEMICAL INDUSTRIES EXPOSITION DRAWS LARGE ATTENDANCE

What was probably the most colorful and expansive display of scientific apparatus and industrial equipment ever assembled in its field, the 22nd Exposition of Chemical Industries was held in Grand Central Palace, New York City, November 28 to December 3.

The scope of the exposition included everything required to bring the research laboratory or the chemical processing plant completely up-to-date. It offered many newly isolated substances for experimental purposes, while numerous exhibitors demonstrated their readiness to develop new appliances for investigation, new machinery for advanced lines of manufacture, even to design and build whole new chemical plants.

MELTING and FINING

BORAX... B_2O_3 even in small quantities in a properly adjusted glass batch will improve the melting and fining time and thus effect a desired economy.

Another good reason why Borax should be used as an essential ingredient in the batch formula.

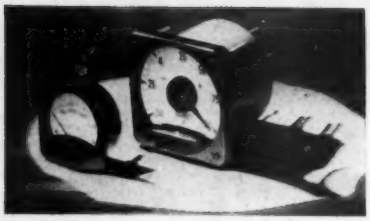
• • •

Our representatives are prepared to discuss all the special advantages of B_2O_3 in glass.

PACIFIC COAST BORAX COMPANY

NEW YORK • CHICAGO • LOS ANGELES

NEW EQUIPMENT AND SUPPLIES



G-E TEMPERATURE INDICATORS

General Electric Company, Schenectady 5, New York, has announced a new line of temperature indicators for industrial and laboratory use. Included in the line are cold-end compensated thermocouple thermometers for measuring temperatures up to 3000°F. and resistance thermometers for temperatures up to 300°F.

The thermocouple thermometer is available in two sizes: the Type DO-71 (left above) with a 3½-inch flange and the DW-71 (right above) with a 2½-inch flange. The thermocouple thermometer can be used for temperature measurement in applications such as industrial furnaces, infra-red drying ovens, melting pots, ceramic kilns, etc.

Designed for the measurement of low temperatures where high accuracy is important, the resistance thermometers are available in two standard types: the DB-15 long-scale instruments and the Types DD-6 and DD-7 six-inch rectangular, surface- and flush-mounted instruments.

FIBER GLASS FINISH

Brooklyn Varnish Company, 50 Jay Street, Brooklyn 1, New York, has announced the development of Tuf-On Filaplast, a finish for fiber glass and plastics.

Filaplast performs the dual function of adhering tenaciously to fiber glass and plastic surfaces, and of filling indentations whenever they occur on the surface. Based on phenolic resins, it may be applied by a putty-knife or squeegee, or may be thinned for spray application. It sands easily and dries in several hours. The firm reports that it forms an ideal base coat for enamels and lacquers without lifting. Filaplast is flexible and moisture resistant and provides a non-cracking and non-chipping finish on molded fibre glass and plastics.

GOLD DECALCOMANIAS

Palm, Fechteler & Company, 220 West 42nd Street, New York 18, N. Y., has announced the development of a 23K gold film application for decalcomania purposes.

According to the company's announcement, gold effects have always presented a problem for such decal usages as gold striping, decorative display and other functions. With the new type of gold application, such problems as application, appearance, wear, tarnishing and mass production are no longer bothersome. It is possible to obtain this decalcomania film for gold striping or other forms of decoration in lengths up to 45", in widths from ⅛" to 2".

NEW DIAL MICROMETER

E. J. Cady & Co., 134 N. La Salle St., Chicago 2, Ill., has announced the Cady hand model micrometer especially designed for easy portability and convenient for inspecting, checking and comparing thicknesses in various locations throughout the plant, on the production line or on the road.

The dial is glass covered, 2¾" in diameter, graduated in thousandths of an inch. Anvil is 9/16" diameter and permits calipering of thicknesses up to one-half inch on materials requiring accurate thickness measure. Anvils can also be supplied with larger or smaller diameters and flat or spherical ends when specified. This instrument is made to close tolerances for accurate calipering. An external adjustment is incorporated for maintaining dial indicator at exact zero.

CATALOGUES RECEIVED

Selas Corporation of America, Philadelphia 34, Pa., is distributing a booklet covering its combustion controllers.

The booklet discusses the Selas heating principle. It illustrates various installations of Selas combustion controllers and describes the unit's operation, its uses, its control, its design and construction — shown also by line drawing—its capacities and pressures, accessory equipment, controller selection procedure. Tables are included which show positive type controllers and centrifugal type controllers information.

De Laval Steam Turbine Company, Trenton 2, New Jersey, has issued a new catalogue featuring its De Laval-Imo Pumps.

The catalogue shows cut-away drawings of the six different types of De Laval-Imo rotary pumps, along with a brief description of each. The Imo pump is designed to handle residual and distillate fuel oils, crude oils, all grades of lubricating oils, hydraulic oils, viscous fluids and liquids of similar characteristics.

Capacities range from 0.5 to 1000 gpm. for pressures to 500 psi. and capacities to 150 gpm. for pressures to 1500 psi.

Dravo Corporation, Pittsburgh 22, Pa., has announced the publication of an illustrated brochure devoted to mechanical ventilation of industrial structures to remove air contaminated by fumes, dust or gases.

The bulletin, #520, explains the method in which fresh air is introduced into a factory structure and the advantages in such a system. The use of Dravo "Counterflo" Heaters are described in the brochure and the functions they perform.

Fuller Company, Catasauqua, Pa. has issued Bulletin FK-25 which illustrates and describes unloading and conveying of dry pulverized materials.

The booklet illustrates a typical illustration and gives information concerning industrial applications. A discussion of the complete system is given, with data on cost saving and operation. Line drawings illustrate details of construction and operation of the Fuller-Kinyon Type L stationary pump.

The bulletin further illustrates and discusses various phases of the conveying system and lists the products most suitable for conveying by the company's system, such as soda ash, lime, kaolin, barytes, dolomite, barium sulphate, limestone, magnesite, etc.

Cambridge Wire Cloth Company, Cambridge, Maryland, has published Bulletin 87 featuring its woven wire cloth, wire screens and filter cloth.

The four-page folder illustrates the various screens available for these three products and lists the branch offices of the firm.

Mine Safety Appliances Company, Pittsburgh 8, Pa., has issued a four-page bulletin describing Lira, an infrared analyzer for measuring atmospheric contamination and precise process control.

The booklet illustrates and describes the Lira and gives an extended description of the analyzer and its operation.

The American Refractories Institute, St. Louis 1, Missouri, has issued its Technical Bulletin No. 87 entitled "Suggestions for a Glossary of Terms Relating to Refractories, Their Manufacture and Use".

After an introductory section, the booklet goes on to list the suggested glossary of terms.

Thermo Electric Company, Fair Lawn, New Jersey, has issued a four-page folder, designated Instrument Section 25, devoted to its pyrometer indicators.

The bulletin describes the instrument, with illustrations, and gives scale ranges, prices and applications. The folder also shows and briefly describes some of the company's other products.

Chain Belt Company, Milwaukee, Wisc., has just published Bulletin #49-3 describing and illustrating the Baldwin-Rex Double Pitch Roller Chain.

The four available types of Baldwin-Rex double pitch roller chain and the wide range of attachments for this chain are illustrated.

Special double duty sprockets, which considerably lengthen the life of the chain, are available for use with the Baldwin-Rex double pitch roller chain. These sprockets are also described and illustrated.

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*Trade name of Kimble Glass, Division of Owens-Illinois Glass Co.

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THAT CURIOUS WORD "LEHR" . . .

(*Continued from page* 29)

ing invented an entirely new process for the annealing of the glass. But such use is entirely unwarranted; for the original word "leer" connotes, as I shall show below, the full principle involved in the continuous annealing process.

The Word "Leer"

In the year 1662 Christopher Merret, a doctor of medicine and a Fellow of the Royal Society, published in London his book entitled *The Art of Glass*. The work consisted of two parts, namely, a translation of the first edition in Italian of Antonio Neri's *L'Arte Vitraria* and Merret's own observations. The translation itself occupied 203 pages, whilst the observations filled another 165 pages. Neri's original book in Italian did not include any diagram or descriptions of furnaces, and as a preface to his detailed observations Merret regarded it as desirable to enlighten the reader on the general construction of glass-making furnaces. In doing so he not only drew on the accounts set down by Agricola in *De re metallica*, but also described the special features associated with English practice of the seventeenth century.

It is in Merret's observations that we first find the use of the word "leer" in glass-making literature. The word first occurs on page 241 of the edition of 1662. The most important reference for our purpose appears on pages 243 to 244 and I quote the whole paragraph:

> "The *Leer* (made by *Agricola*, the third *furnace*, to anneal and cool the vessels, made as the second was to melt the Metal, and to keep it in fusion) comprehends two parts, the *tower* and *leer*. The *tower* is that part which lies directly above the melting *furnace* with a partition betwixt them, a foot thick, in the midst whereof, and in the same perpendicular with that of the second *furnace*, there's a round hole (*Imperat.* and *Agric.* make it square and small) through which the flame and heat passeth into the *tower;* this hole is called *Occhio* or *Lumella*, having an iron ring encircling it called the *Cavalet* or *Crown*, on the floor or bottom of this *tower* the vessels fashioned by the manufacturers are set to anneal; it hath 2 *Boccas* or mouths, one opposite to the other, to put the glasses in as soon as made, taken with a fork by the *Servitors* and set on the floor of the *tower*, and after some time these glasses are put into iron pans (*Agric.* makes them of clay) called *Fraches*, which by degrees are drawn by the *Sarole man* all along the *Leer*, which is five or six yards long, that the glasses may cool *gradatim*, for when they are drawn to the end of the *Leer* they become cold. This *Leer* is continued to the *tower*, and arched all along about four foot wide and high within. The mouth thereof enters into a room, where the glasses are taken out and set. This room they call the *Sarosel*, and the *Sarole*-men those who draw the *Fraches* along the *Leer*, and take them thence".

There are two points to emphasize. The first is that the original meaning of the term "leer" is precisely that which it still bears in the most modern forms of apparatus for continuous annealing, namely, an apparatus, arrangement or plant for the annealing of glass immediately after manufacture by passing it at a controlled rate ("*gradatim*") down a tunnel, the one end where the glassware is introduced being hot, and the other, where it emerges, cold. The second is that Merret does not from the context appear to have proposed the use either of the term "leer" or of any of the other workshop terms; the internal evidence is that he only records the technical terms already in general use.

I have previously discussed the question as to whether or not the word "lehr" had a German origin, and have shown that there is no similar term whatever in use in the German glass-making literature of the nineteenth or of the present century. Full and complete confirmation, however, that the word "leer" was devised and used in England to connote a special process of annealing glass occurs in the German work by Johann Kunckel, entitled *Ars Vitraria Experimentalis* (*oder Vollkommene Glasmacher Kunst*) published in Frankfort in 1679. Kunckel was the foremost German chemist of his day. Glass-making was one of his special interests, and he is known in history as the inventor or rediscoverer of gold ruby glass. He, too, for the benefit of German glass-makers, undertook the translation of Neri's book not, however, from the original Italian in which Neri wrote it, but from the English version prepared by Merret. Moreover, he translated and published all the additional observations by Merret, and finally added comments on both Neri and Merret embodying his own experience.

Merret first used the word "leer" on page 241 of his book. The original phrase and Kunckel's corresponding translation are as follows:

Merret. p. 241, last line.	Kunckel. p. 239, last par.
"the second partition divides this from the Leer."	"Der andere und obere Theil des Ofens theilet solchen von der *Leera* (ist ein Englisches Wort und soll vielleicht den Kühl-Ofen oder das dritte Gewölb des Werckofens bedeuten) ab."

Kunckel thus states categorically that the word "leer" is an English word, and in his own text he converts it into a Latin form "leera", and declines it like a Latin substantive so that, according to the passage, the words "leeram" and "leerae" occur. In all these forms the word appears in Roman type to contrast it with the Gothic type normally used throughout the text, in the same way that we use italics.

Having established beyond doubt that the word "leer" is of English origin, it is natural to conjecture how it came to be used. Here we come entirely into the realm of conjecture. According to the *Shorter Oxford English Dictionary*, the first use of the word in the English language occurred in 1662, that is to say, in Merret's book. Presumably it was then in use amongst glass-makers in England. It could have been introduced by the Norman glass-makers, who were well established at the beginning of the thirteenth century at Chiddingfold, Surrey, and who, in the course of the next three or four centuries, spread through Surrey, Sussex and the wooded areas of southern England. The only other glass-making immigrants likely to have influenced glass-making terminology

(*Continued on page* 46)

A NEW BATCH MATERIAL FOR 1950

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Calumite is a blast furnace slag particularly suited as a glassmaking raw material. Even though in use a relatively short time, it has already been acclaimed the outstanding glass batch constituent for amber glass.

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HAMILTON, OHIO

THAT CURIOUS WORD "LEHR" . . .

(*Continued from page* 44)

were the Venetian and Italian glass-workers, who began to come to the country at about the middle of the sixteenth century, and those from Lorraine, who began to appear towards the end of that century. I have already shown, however, that it is improbable the Venetians introduced the term "leer". There is no evidence that the Lorrainers were responsible, and I have previously mentioned that neither in de Blancourt's *L'Art de Verrerie* of 1697 nor in the books of the nineteenth century is any such term employed.

There are words in modern Norwegian which are suggestive in connection with the derivation of the word as applied to glass annealing. Thus the word "leir" means a resting place or camping place. The forms "leire" and "lere" denote clay, (as does the old celandis "leir", and "leir-pottr" means "earthen pot") whilst "leie" can denote a laying-down place. It is of interest to recall that the Northmen, particularly the Norwegians, conquered and settled in Normandy in the ninth and early part of the tenth centuries, and their stock gave rise to the Normans whose activities, transferred to England, included glass-making.

The *Oxford English Dictionary*, 1903, Volume VI, Part I, edited by Henry Bradley, suggests that the word "leer" may have had its roots in one of several Anglo-Saxon words, and that there were near relatives in Middle Dutch, Middle Low German and Old Norse. The word "leer", however, has many meanings and why it should connote an apparatus or device for the annealing of glass must remain obscure.

Conclusions

The term "lehr" to denote an apparatus or plant for the continuous annealing of glass first appeared in factory usage in the U.S.A. between 1890 and 1900. The word arose most probably by corruption of the original form "leer", but whether by accident or design is obscure. It does not connote any new method or principle which is not already implied by the much older word "leer". On the ground of long historical usage there is full warrant for restoring the word "leer" to glass technological terminology and of abandoning the use of the form "lehr".

AMERICAN OPTICAL REVEALS WARTIME PROCESS

A secret, wartime method of mass producing Schmidt corrector plates, a lens ten times faster than a high-speed camera lens, has been revealed by the American Optical Company.

Dr. E. D. Tillyer, company Research Director and inventor of the process for which a patent has just been granted, said that many thousands of the complex glass lenses were manufactured during the war for military devices whose uses have not yet been revealed by the Government.

"Prior to the war," Dr. Tillyer said, "there were less than fifty lenses of this Schmidt correcting type in the world and these were used in high-speed astronomical photography. Weeks and sometimes months were required by a skilled lens grinder to make one by hand. Because of the multiple curves of the lens, mass production was considered impossible."

Dr. Tillyer discovered after the war that he had won a race against German scientists who had been working night and day to perfect a method of making the lens by "dropping". Dropping, although known for years, had several inherent and serious defects in producing Schmidt lenses which require extreme accuracy. The mold would expand faster or slower than the glass plates; it would not contract to its original shape, thus making it unfit for reuse; and the glass had a tendency to stick to the refractory. When powder was dusted on the refractory to prevent sticking, the powder tended to distort the finished lens.

After extensive research and experimentation in compounding the half-dozen materials used in forming his refractory, Dr. Tillyer produced a mold having practically no tendency to become distorted. He obtained this control by pitting two materials, kyanite and ball clay, against each other. Kyanite has a tendency to expand while ball clay tends to contract. His composition also precludes sticking. In addition, the materials of the refractory absorb the infrared radiations which pass through the glass during the heating and dropping and thus heat the glass from both sides. This results in more uniform heating.

GLASS FIBERS APPOINTMENT

W. R. Smith has been appointed Sales Manager of the Mat Division of Glass Fibers, Inc., according to an announcement made by R. W. Capaul, General Sales Manager of the firm.

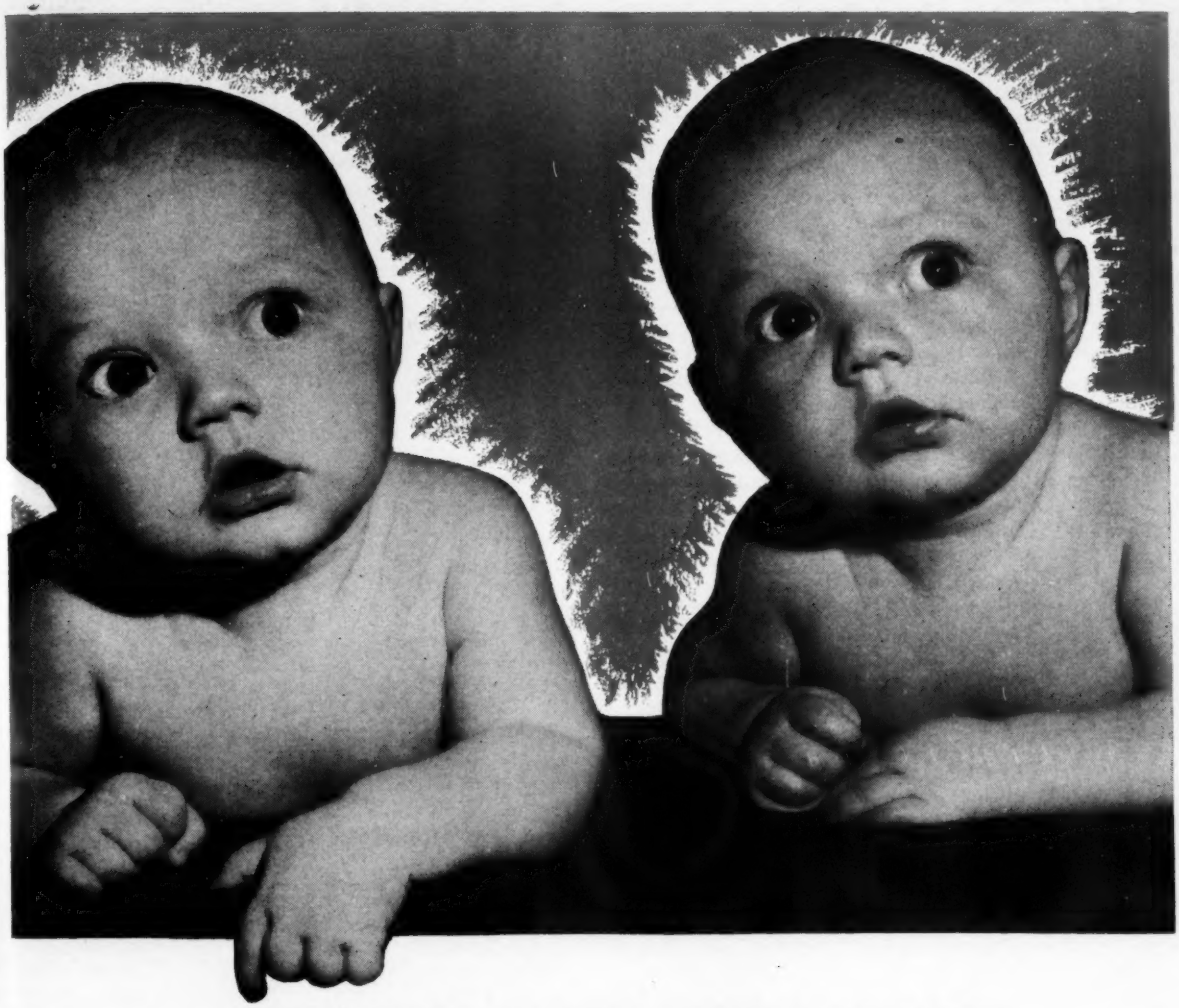
Mr. Smith had been employed in various sales and expediting capacities with the investment firm of Stranahan, Harris and Company, Willys Overland Motors, Inc., Hickol Oil Corporation and Curtis Publishing Company. During World War II, he was with the Army Ordnance Department.

BOOK ON CURRENT RESEARCH PUBLISHED BY RESEARCH COUNCIL

The Engineering College Research Council of the American Society for Engineering Education has announced publication of the 1949 "Review of Current Research" in which are listed over 4000 current college and university research projects in engineering subjects representing expenditures of over $35,000,000.

Entries in the book from eighty-two educational institutions which hold membership in the Research Council describe the administrative policies for conducting engineering research and list the responsible personnel, research expenditures, short courses and conferences of special interest, and the titles of all engineering research studies currently active at each institution. Use of the volume is facilitated by a breakdown of research projects according to the engineering departments involved, and by a complete index to research project subjects.

Copies of the book are available at the cost of $1.75 postpaid, paper bound, more than 180 pages. Orders should be addressed to F. M. Dawson, Chairman, care of the College of Engineering, State University of Iowa, Iowa City, Iowa.



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ELEVENTH GLASS CONFERENCE AT URBANA . . .

(*Continued from page* 22)

opposite in sign from the stress-release during cooling" was not true if there was residual stress in the glass before heat-treating. Of course, after the temperature of glass being annealed drops below the strain-point, the cooling rate is limited only by the need to prevent breakage. Mr. Lillie presented interesting curves and data from which annealing cycles may be determined for glass with thickness variations, different thermal expansions, and for different degrees of temperature in the annealing range.

The practical aspects of annealing hollow ware were presented by F. E. Dorsey of Hartford-Empire Company, who discussed effects of variation in lehr capacity, and also gave a method for determining practical lehr temperatures based on strain—and annealing-point values. An interesting point brought out by Mr. Dorsey was that better annealing is obtained in a decorating lehr because of uniformity and constancy of load. He also predicted increased employment of tempering methods to strengthen hollow ware.

The physical form changes through which glass passes during tempering were aptly outlined by Dr. R. K. Day, of Libbey-Owens-Ford Glass Company, after which Harold McMaster, of Permaglas, Incorporated, discussed the practical problems encountered in tempering flat glass. Dr. Day illustrated a horrible example called a "Whatzit", showing the structural characteristics to be avoided in an article which is to be tempered. He also described various methods for testing tempered glassware. Dr. Day's paper will be found elsewhere in this issue.

Mr. McMaster pointed out the necessity for close control of furnace temperatures in flat glass tempering. He stated that furnaces designed for metal heating rates may be used for heating glass, but their heating capacity has to be adjusted because glass does not become heated in the same manner as the black body, metal. He compared practical heating curves with the Stefan-Bolzman law of heating by radiation, and with Newton's law of heating by conduction. The economy of using higher furnace temperature to permit faster operation is obvious, but the time of heating is correspondingly made more critical. Mr. McMaster concluded by stating that problems in tempering would be simplified if it were possible to measure the surface temperature of every piece of glass processed.

W. H. Manring, Ball Brothers Company, presented a well-organized paper outlining conditions necessary to maintain the proper balance needed to successfully melt amber glass. He cited a paper by Coles in THE GLASS INDUSTRY, August 1947, entitled "Mechanics of Amber Formation", and also named several materials useful in preventing excess sulfur from existing in the glass melt.

The conference concluded with papers on quality control by Dr. J. H. Toulouse, Owens-Illinois Glass Company, Dr. K. C. Lyon, Armstrong Cork Company, and F. L. Bishop, American Window Glass Company, after which these three experts answered, in an open forum, written questions submitted by those attending. Dr. Toulouse gave an interesting history of quality control up to the present time, and described control charts as mathematical alarm clocks, pointing out that their greatest value is in control of actual production operations. He also related that the greatest advances have been made not by mathematicians, but by those who have become interested in applying quality control.

Dr. Lyon discussed good and bad sampling plans, and further elaborated on the use of control charts applied to container ware manufacture. Then Mr. Bishop told of opportunities for their beneficial use in flat glass manufacture.

The large amount of interest in this fairly new method of preventing formation of grey hair was manifested by the number and type of questions submitted to the panel for discussion. A bibliography of worthwhile books on the subject was presented, together with a number of examples of how common-sense use may be made of quality control theory for getting answers to many different type problems.

All of the papers presented at the conference will be published in their entirety before the 1950 conference, which will be held at the Ohio State University, Columbus, Ohio.

DOMINION GLASS BUSINESS REPORT

Dominion Glass Co. net profit for the year ended Sept. 30, 1949 was off 7.1%. Volume was maintained at approximately the same level as last year. Demand for company products appears to have resumed prewar seasonal character resulting in idle furnace capacity during the winter months with increased costs. The upward trend in costs lowered the narrow margin of profit on which the industry operates, the annual report states.

Plant modernization and replacement which commenced several years ago is still in progress. Alterations at Hamilton will be completed in 1950. Expenditures on capital account amounted to $888,673 for the year. Unexpended balance on approval works at fiscal year end, amounted to $430,981. Further substantial expenditures are under consideration to replace worn and obsolete equipment and for the other necessary improvements.

The company's total net income in the fiscal year ended Sept. 30, 1949 amounted to $3,081,228 as compared with $3,232,223 in preceding year and net profit was $1,497,285 as against $1,612,471, with surplus for year being $890,285 against $1,132,971; total current assets, $9,767,532 against $8,936,293; total assets, $21,750,300 against $20,589,487; total current liabilities, $2,558,853 against $2,583,492; working capital, $7,208,679 against $6,352,801.

FIBERGLAS NAMES TRAFFIC MANAGER

The appointment of J. M. Carey as General Traffic Manager has been announced by Owens-Corning Fiberglas Corporation. Prior to joining Fiberglas, Mr. Carey was Traffic Manager for the Krafco Container Corporation.

Mr. Carey began his industrial transportation career in 1926, joining the Universal Gypsum & Lime Company as assistant traffic manager, later becoming Traffic Manager of the firm and its successor, National Gypsum Company.

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BASIC PRINCIPLES OF GLASS TEMPERING . . .

(*Continued from page* 25)

glass surfaces. Drop tests, in which the article itself is dropped onto a surface of constant hardness, have been used, but articles do not always hit the surface in the same way and intense vibrations which may not always be the same are induced.

The dropping of a steel ball onto the article is a test frequently used to simulate the use requirement of the tempered glass article. To the extent that it meets the service requirement, the steel ball drop test is good. A small accidental protrusion on the ball or a chip of glass accidentally left on the surface of the glass may, however, affect this test by causing a small fissure to go into the tension zone.

Except for specific use tests, such as the above, probably the most satisfactory overall test of a tempered glass article is the water-quench. Reference to the series of diagrams showing the cross-sectional stress patterns during the heating and quenching operation, reveal that a water-quench reverses the compression forces on the surface and a water-quench test is therefore a measure of degree as well as uniformity of temper in the article. If the water-quench test is set below the severity which a well-tempered article will stand, it is a good 100 per cent test to cull out by breaking improperly tempered pieces and thus guarantee the quality of the tempered product. On a special test basis to destruction, the articles are generally heated in an air-oven at successively higher temperatures followed by quench in an ice bath. When using an ice bath, it is advisable to drop the glass into a wire basket which is suspended in the water-ice mixture in a manner which prevents the glass hitting actual pieces of ice. If the test is to be a 100 per cent test in the production line, the test quench, preferably into water, may be introduced into any part of the operation which uniformly quenches the glass articles to an empirically determined degree which breaks bad ware and allows good ware to survive. Since this test deliberately introduces temporary tension on the glass surface, mechanical abuse as the glass hits the water is again to be avoided. The thermal shock quench test has been found in practice to show a smaller spread of values than other types of mechanical tests and is therefore recommended as probably the best overall test for the strength of a tempered article.

Summary of Tests

Tests for tempered glass may be classified into destructive tests on limited samples with Quality Control chart analysis, or 100 per cent non-destructive inspection as follows:

Under destructive tests we have:

1) Cross-section examination with Babinet or quartz wedge;

2) Break test by drilling, examine size of pieces;

3) Article drop test to destruction from successively higher platform heights;

4) Steel ball dropped on article test, successive heights to destruction using a new piece of glass for each drop; and

5) Thermal shock to destruction.

Under 100 per cent non-destructive tests we have:

1) Thermal shock test set to be equal to minimum required strength of article and

2) Polariscope visual examination though basically unreliable to catch articles not properly processed.

EFFECT OF ALUMINA ON TENSILE STRENGTH OF GLASS . . .

(*Continued from page* 21)

When values for the tensile strength are plotted against the percentage of alumina, there is a sharp increase in tensile strength, followed by a constant decrease. The maximum strength is at 1% of Al_2O_3 in the group of glasses with the higher silica content and at about 2% of Al_2O_3 with a lower silica content.

IV. Conclusions

The substitution of alumina for lime in a soda-lime-silica glass tends to increase the tensile strength up to approximately 2%. Further additions of alumina tend to decrease the tensile strength. The apparatus used gives results that are in good agreement with other investigators.

FOOTNOTES

[1] General Engineering Handbook, 2nd. ed., McGraw-Hill Book Co., Inc., New York, 1949; p. 190.

[2] F. O. Anderegg, "Strength of Glass Fiber", Ind. Eng. Chem., 31, 290-98, (1939).

[3] S. R. Scholes, Modern Glass Practice, Ind. Pub., Inc., Chicago, 1946; p. 206.

NATIONAL BUREAU OF STANDARDS ISSUES SPECTROPHOTOMETRY BOOKLET

The National Bureau of Standards has made available through the U. S. Government Printing Office a new booklet, Spectrophotometry.

The techniques and data resulting from the Bureau's extensive experience in spectrophotometry are presented in this guide so that the users of spectrophotometers can better understand their instruments, calibrate and maintain them in the proper operating condition, and guard against the numerous errors common in such work.

Instruments and methods for use in the ultraviolet, visible and near-infrared spectral regions are considered, including photographic, visual and photoelectric methods. Important topics covered include definitions of spectrophotometric terms, essential parts of spectrophotometers, typical instruments in current use, types of errors which usually occur in spectrophotometric work and presentation of standard data for checking the calibration of spectrophotometers. In addition, a bibliography of 127 related references is given.

The booklet may be ordered as follows: Circular 484, Spectrophotometry, 48 large double-column pages, illustrated, available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 25 cents a copy. Remittances from foreign countries must be in United States exchange and must include an additional sum of one-third the publication price to cover costs of mailing.

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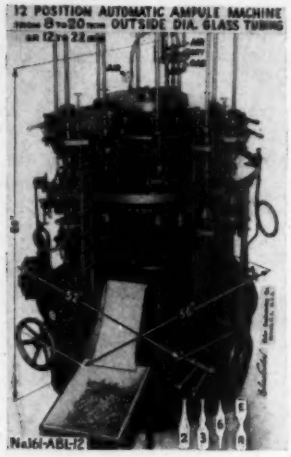

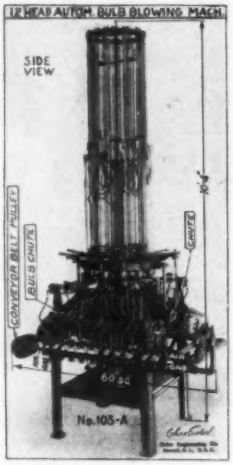

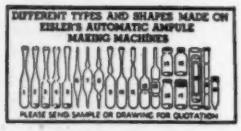
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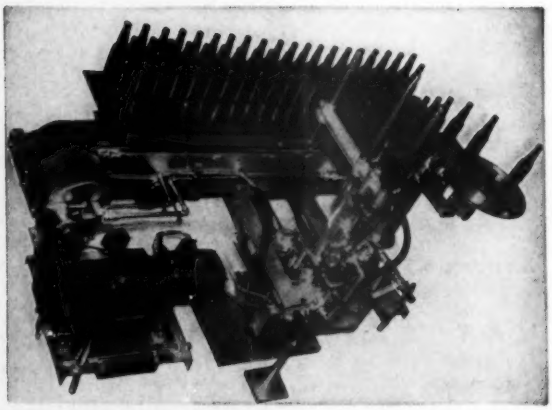

GLAPAT CORPORATION
Zanesville, Ohio

INDUSTRY CONFERENCE STUDIES ACCIDENT PREVENTION . . .

(*Continued from page* 30)

life and health by other means than that included in structural design."

Included on the conference program was also one technical paper on "Safety Design For Glass Batch Plants," presented by another Corning Glass Works representative, Frederick S. Kriger, Manager of the plant engineering department at Corning.

H. V. Gardner, Safety Director, glass container division, Owens-Illinois Glass Company, Toledo, Ohio, in presenting his report as retiring chairman of the Glass and Ceramics Section, told of the various activities of the executive committee during the year. "We're the youngest and smallest of the National Safety Council's sections," he said, "so we still have many shortcomings. But we're getting good support and we're going to continue forward as best we can."

James L. Morris of Federal Glass Company, Columbus, Ohio, in presenting his report as Secretary of the Section, raised the question of the desirability of establishing a research project for the Section and also an accident reduction contest with awards, similar to what other National Council Sections conduct annually. Two new committees have been proposed, he said, one to contact and solicit the support of interested trade associations, and a second, to deal with statistics and the proposed contest.

Three new ideas for posters dealing specifically with accident hazards in the industry have been submitted for consideration, he announced. The editor of the Section's News Letter has been heartened by a steady increase in contributions from members, but Mr. Morris urged that everyone become personally interested in providing stories of safety plans and programs in effect in their plants.

In the election of officers for the coming year the following slate was unanimously endorsed: General Chairman, John P. Stephenson, Ball Bros. Company, Muncie, Ind.; Vice Chairman, James L. Morris, Federal Glass Company, Columbus, Ohio; Secretary, J. C. Dittmar, National Lead Company, Brooklyn, N. Y.

Floyd Frazier was introduced as the new National Safety Council staff representative and adviser to the Section. He protested, however, that he is not an "adviser", but a "student".

"We're all on the same level in this accident prevention work," said Mr. Frazier, "and we must pitch in to get things done. There's no need for you folks to apologize for what you have accomplished in your first two years of existence. You have done everything expected of you. We have a lot of plans in the making and we must pool our knowledge. I hope you will feel free to call on me for any help I can give you."

• The Pittsburgh Plate Glass Company has announced a complete line of standard Carrara structural glass window sills. The sills will be furnished in black, white, gray, ivory and tranquil green in 1¼-inch thickness and in all of these colors, except tranquil green, in ¾-inch thickness.

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INVENTIONS AND INVENTORS . . .
(Continued from page 35)

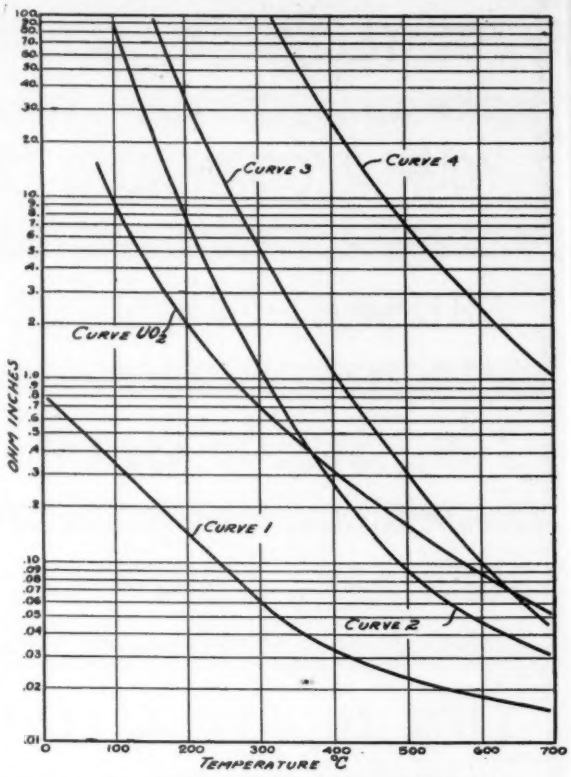

Fig. 14. Electrode for Electric Melting of Glass.

sition withstands the action of molten glass and is a good conductor of electricity at the usual glass melting temperatures and even higher.

As examples illustrating the invention, the following compositions in parts by weight are given:

	1	2	3	4
Stannic oxide	100	100	100	100
Cupric oxide	0.5	0.5	1.0	2.0
Antimony trioxide .	1.0	.....	.....	.....
Cupric arsenite ...	.....	1.5	.....	.....
Bismuth trioxide ..	.....	.....	2.0	.....
Tantalum pentoxide	.....	.....	.....	4.0

The figure shows the change in electrical resistivity with change in temperature for the four examples given above. For comparison, a curve marked UO_2 illustrates the most effective use of uranium in a composition consisting of 96% SnO_2, 2% CuO and 2% UO_2. This composition is set forth in Mochel's prior Patent No. 2,467,144. The patent gives all details for the manufacture of this material.

The following references are of record in the file of this patent: 1,502,421, Cooper, July 22, 1924; and 1,517,618, Cooper, Dec. 2, 1924.

Electrode for Electric Melting of Glass. Fig. 15. Patent No. 2,490,826. This is another invention by John M.

(Continued on page 56)

One of a series *of messages to help you increase your understanding of business paper advertising, and its effect on your job.*

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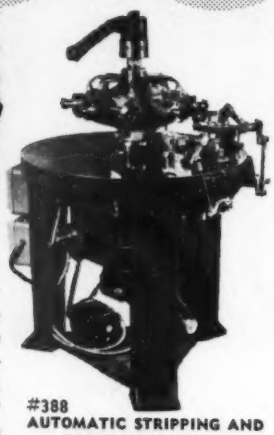

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INVENTIONS AND INVENTORS . . .

(*Continued from page* 54)

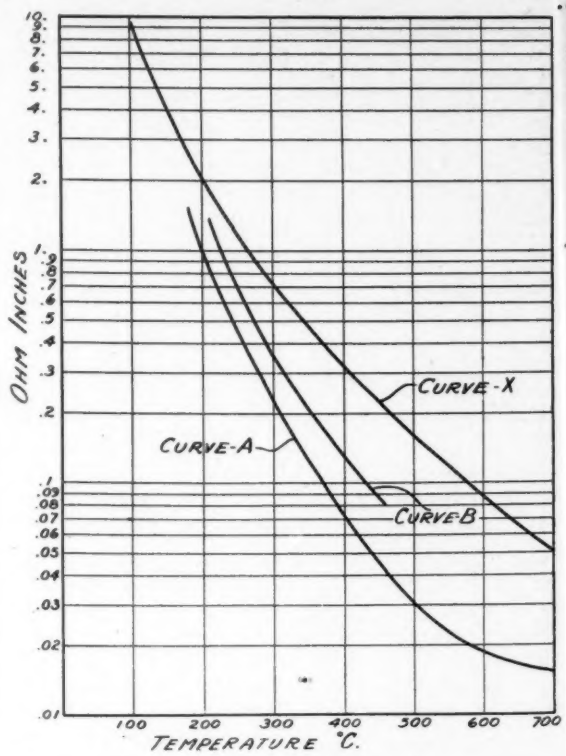

Fig. 15. Electrode for Electric Melting of Glass.

Mochel similar to the above and also assigned to Corning Glass Works.

The refractory may be compounded, shaped and fired in any well known manner such, for instance, as that disclosed in the patent to Hood, No. 2,244,777.

The following compositions, in approximate percentages by weight as calculated from their batches, have been found particularly suitable:

	A	B
SnO_2	97	97.5
CuO	1	0.5
UO_2	1	1
Sb_2O_3	1	....
Bi_2O_3	..	1

Curve X represents approximately the ratio of temperature to resistance of a composition consisting of 96% SnO_2, 2% CuO and 2% UO_2. The curves A and B correspond to the compositions in the above table.

No references were cited by the Patent Office.

• The appointment of Stuart A. Whitehurst as Pacific Coast representative of Selas Corporation of America has been announced. During the past twenty-seven years, Mr. Whitehurst has been active in industrial designing and operation, as well as in sales engineering.

G. C. M. I. RETURNS TO MIAMI FOR SEMI-ANNUAL MEETING . . .

(*Continued from page 26*)

sand used for glass manufacturing purposes and that of shipping common sand in open cars might be used to obtain lower rates on the former.

Another ICC observation featured in the Committee's report dwelt on the diversion or suppression of traffic, due to high rates, which was interpreted as a foreclosure against further general rate increases for some time to come.

The Committee also reviewed the efforts it was making to obtain reductions on freight rates on glass containers, sand and soda ash.

The Committee on Government-Industry Relations, through its Chairman, S. B. DeMerell of the Anchor Hocking Glass Corporation, reported continuance of its activities in regard to government regulations on tin and tin plate, on the trade agreements program and tariff matters and on the gas producer research program at Battelle Memorial Institute. In the latter case, the Committee reported, the conversations between its Sub-Committee and Battelle culminated in a recommendation to the Trustees that the Institute participate in a research project jointly sponsored by Bituminous Coal Research, Inc., Diesel Engine Manufacturers' Association, Battelle Memorial Institute and GCMI. Acting on the recommendation, the Trustees appropriated $12,000 to cover the Institute's share of the project from mid-1949 to mid-1951. Progress reports on the research, the report advised, have been excellent.

Other activities reported by this Committee included contacts with the Department of Agriculture and the Department of Commerce—the first in regard to procurement of food items for the School Lunch Program, as well as with its work with various commodity groups in formulating package and shipping container specifications; the second with respect to orders and regulations administered by the Department of Commerce, as well as on matters of interest to business generally. The Committee also reported contacts with the Military Establishment personnel in change of procurement and package specification. Mr. DeMerell also covered the dissemination of data on imports and exports of glass containers to various foreign countries compiled by the government, as well as dissemination of statistics on the size of fruit and vegetable packs prepared by the National Canners Association, especially in regard to items where glass is extensively used.

In submitting the report of the Technical Committee on Glass Packed Products, its Chairman, John M. Sharf of the Armstrong Cork Company, summarized the results of the research program at the University of Massachusetts, including such aspects as the effect of container shape and size on circulation of the products during heating; the control of thermally resistant organisms which might cause spoilage; studies on the enzyme systems present in foods, and correlated studies on volatile reducing substances found in packaged foods as a means for indicating "staleness"; correlation of spoilage data with heat penetration data in regard to fresh kosher style dill pickles, etc.

The Committee advised that the cooperative studies which led to the publication jointly with the National

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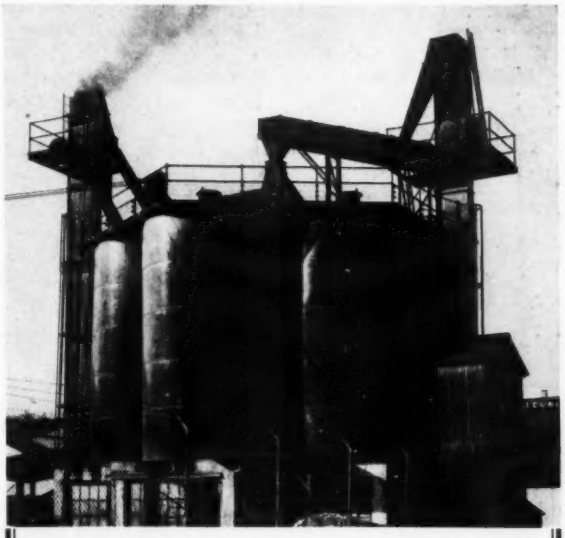

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